U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-248 599

ECONOMIC ANALYSIS OF EFFLUENT GUIDELINES

CANE SUGAR REFINING

DEVELOPMENT PLANNING AND RESEARCH ASSOCIATES

PREPARED FOR
ENVIRONMENTAL PROTECTION AGENCY

NOVEMBER 1975

KEEP UP TO DATE

Between the time you ordered this report—which is only one of the hundreds of thousands in the NTIS information collection available to you—and the time you are reading this message, several *new* reports relevant to your interests probably have entered the collection.

Subscribe to the **Weekly Government Abstracts** series that will bring you summaries of new reports *as soon as they are received by NTIS* from the originators of the research. The WGA's are an NTIS weekly newsletter service covering the most recent research findings in 25 areas of industrial, technological, and sociological interest—invaluable information for executives and professionals who must keep up to date.

The executive and professional information service provided by NTIS in the **Weekly Government Abstracts** newsletters will give you thorough and comprehensive coverage of government-conducted or sponsored research activities. And you'll get this important information within two weeks of the time it's released by originating agencies.

WGA newsletters are computer produced and electronically photocomposed to slash the time gap between the release of a report and its availability. You can learn about technical innovations immediately—and use them in the most meaningful and productive ways possible for your organization. Please request NTIS-PR-205/PCW for more information.

The weekly newsletter series will keep you current. But *learn what you have missed in the past* by ordering a computer **NTISearch** of all the research reports in your area of interest, dating as far back as 1964, if you wish. Please request NTIS-PR-186/PCN for more information.

WRITE: Managing Editor
5285 Port Royal Road
Springfield, VA 22161

Keep Up To Date With SRIM

SRIM (Selected Research in Microfiche) provides you with regular, automatic distribution of the complete texts of NTIS research reports *only* in the subject areas you select. SRIM covers almost all Government research reports by subject area and/or the originating Federal or local government agency. You may subscribe by any category or subcategory of our WGA **(Weekly Government Abstracts)** or **Government Reports Announcements and Index** categories, or to the reports issued by a particular agency such as the Department of Defense, Federal Energy Administration, or Environmental Protection Agency. Other options that will give you greater selectivity are available on request.

The cost of SRIM service is only 45¢ domestic (60¢ foreign) for each complete microfiched report. Your SRIM service begins as soon as your order is received and processed and you will receive biweekly shipments thereafter. If you wish, your service will be backdated to furnish you microfiche of reports issued earlier.

Because of contractual arrangements with several Special Technology Groups, not all NTIS reports are distributed in the SRIM program. You will receive a notice in your microfiche shipments identifying the exceptionally priced reports not available through SRIM.

A deposit account with NTIS is required before this service can be initiated. If you have specific questions concerning this service, please call (703) 451-1558, or write NTIS, attention SRIM Product Manager.

This information product distributed by

NTIS U.S. DEPARTMENT OF COMMERCE
National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22161

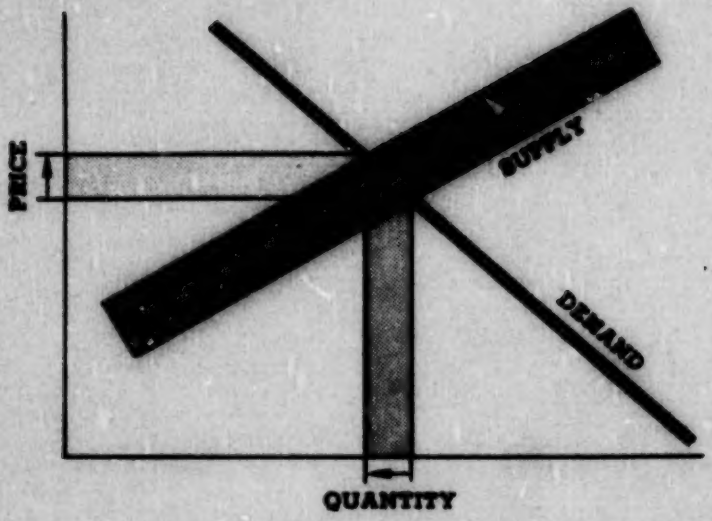
020055

EPA-230/2-75-003
November, 1975

PB 248 599

ECONOMIC ANALYSIS OF EFFLUENT GUIDELINES

CANE SUGAR REFINING



Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
US Department of Commerce
Springfield, VA. 22151

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Planning and Evaluation
Washington, D.C. 20460

BIBLIOGRAPHIC DATA SHEET	1. Report No. EPA-230/2-75-003	2.	3. Recipient's Accession No.
4. Title and Subtitle: Economic Analysis of Effluent Guidelines: Cane Sugar Refining Industry			5. Report Date: November, 1975 Date of completion 6.
7. Author(s): Milton L. David, Robert J. Buzenberg			8. Performing Organization Rept. No. 188-189
9. Performing Organization Name and Address: Development Planning and Research Associates, Inc. P.O. Box 727 Manhattan, Kansas 66502			10. Project/Task/Work Unit No. Task Order No. 5, Mod. 4 11. Contract/Grant No. 68-01-1533
12. Sponsoring Organization Name and Address: Environmental Protection Agency Waterside Mall 4th and M Streets, S.W. Washington, D. C. 20460			13. Type of Report & Period Covered: Final Report 14.

15. Supplementary Notes

16. Abstracts

The cane sugar refining segment of the sugar industry (SIC 2062) is composed of 29 refineries operated by 20 companies. Most refineries, though over 50 years old, have been modernized and operate at full capacity refining raw sugar -- 32 percent the total capacity. Estimated after-tax return on sales are about one percent for all sizes of liquid and crystalline refineries. Prices are controlled indirectly under the price competition from other sweeteners.

Imposition of effluent limitations are not expected to raise prices. Potential refinery closures by 1977 due to the imposition of the effluent limitation guidelines are estimated to be from three to five refineries representing from six to eleven percent of total production. No additional closures by 1983 are expected.

17. Key Words and Document Analysis. 17a. Descriptors

Pollution, water pollution, industrial wastes, cane sugar, sugar refineries, economic, economic analysis, discounted cash flow, demand, supply, prices, fixed costs, variable costs, community, production capacity, fixed investment.

entifiers/Open-Ended Terms

ATI Field/Group: 05 Behavioral and social sciences, C-economics
06 Biological and medical sciences, H-food

PRICES SUBJECT TO CHANGE

18. Availability Statement: tional Technical Information Service Springfield, Virginia 22151	19. Security Class (This Report) UNCLASSIFIED	21. No. of Pages 112 P
	20. Security Class (This Page) UNCLASSIFIED	22. Price 5.50-2.25

NTIS-35 (REV. 3-72)

USCOMM-DC

EPA-230/2-75-003

ECONOMIC ANALYSIS

OF EFFLUENT GUIDELINES

CANE SUGAR REFINING INDUSTRY

Milton L. David
Robert J. Buzenberg

November, 1975

Prepared for
Office of Planning and Evaluation
Environmental Protection Agency
Washington, D. C. 20460

ia

PREFACE

The attached document is a contractor's study prepared for the Office of Planning and Evaluation of the Environmental Protection Agency (EPA). The purpose of the study is to analyze the economic impact which could result from the application of alternative effluent limitation guidelines and standards of performance to be established under sections 304(b) and 306 of the Federal Water Pollution Control Act, as amended.

The study supplements the technical study ("EPA Development Document") supporting the issuance of proposed regulations under sections 304(b) and 306. The Development Document surveys existing and potential waste treatment control methods and technology within particular industrial source categories and supports promulgation of certain effluent limitation guidelines and standards of performance based upon an analysis of the feasibility of these guidelines and standards in accordance with the requirements of sections 304(b) and 306 of the Act. Presented in the Development Document are the investment and operating costs associated with various alternative control and treatment technologies. The attached document supplements this analysis by estimating the broader economic effects which might result from the required application of various control methods and technologies. This study investigates the effect of alternative approaches in terms of produce price increase, effects upon employment and the continued viability of affected plants, effects upon foreign trade and other competitive effects.

The study has been prepared with the supervision and review of the Office of Planning and Evaluation of EPA. This report was submitted in fulfillment of Contract 68-01-1533, Task Order No. 5, Modification 4, by Development Planning and Research Associates, Inc. Work was completed in November, 1975.

This report is being released and circulated at approximately the same time as publication in the Federal Register of a notice of proposed rule making under sections 304(b) and 306 of the Act for the subject point source category. The study has not been reviewed by EPA and is not an official EPA publication. The study will be considered along with the information contained in the Development Document and any comments received by EPA on either document before or during proposed rule making proceedings necessary to establish final regulations. Prior to final promulgation of regulations the accompanying study shall have standing in any EPA proceeding or court proceeding only to the extent that it represents the views of the contractor who studied the subject industry. It cannot be cited, referenced, or represented in any respect in any such proceeding as a statement of EPA's views regarding the subject industry.

TABLE OF CONTENTS

		Page
I.	INDUSTRY SEGMENTS	I-1
	A. Types of Firms	I-1
	1. Size of Firms	I-1
	2. Level of Integration	I-1
	3. Number of Plants	I-7
	4. Products	I-7
	5. Level of Diversification	I-7
	B. Refinery Characteristics	I-7
	1. Size	I-9
	2. Location	I-9
	3. Level of Technology and Efficiency	I-9
	C. Number of Plants and Employment by Segment	I-15
II.	FINANCIAL PROFILE	II-1
	A. Plants by Segment	II-1
	1. Annual Profit	II-1
	2. Annual Cash Flows	II-6
	3. Investment Values	II-6
	4. Cost Structure	II-8
	5. Cost of Capital	II-10
	B. Relationship of Financial Data to Plant Size and Location	II-11
	C. Ability to Finance New Investment	II-11
III.	PRICING	III-1
	A. Price Determination	III-1
	1. Demand	III-1
	2. Government Sugar Policy	III-7
	3. Base Point Pricing	III-14
	4. Supplies	III-14
	B. Expected Price Impacts	III-14
IV.	ECONOMIC IMPACT ANALYSIS METHODOLOGY	IV-1
	A. Fundamental Methodology	IV-1
	1. Benefits	IV-6
	2. Investment	IV-7
	3. Cost of Capital After Tax	IV-7
	4. Construction of the Cash Flow	IV-8
	B. Price Effects	IV-9
	C. Financial Effects	IV-10
	D. Production Effects	IV-11
	E. Employment Effects	IV-11
	F. Community Effects	IV-12
	G. Other Effects	IV-12

TABLE OF CONTENTS (continued)

		Page
V.	POLLUTION CONTROL REQUIREMENTS AND COSTS	V-1
	A. Alternative Effluent Control Levels	V-1
	B. Current Level of Control	V-4
	C. Water Pollution Abatement Costs	V-4
	1. Investment	V-4
	2. Operating and Ownership Costs	V-11
	3. Estimated Costs	V-11
VI.	IMPACT ANALYSIS	VI-1
	A. Price Effects	VI-1
	B. Financial Effects	VI-4
	1. Profitability	VI-4
	2. Capital Availability Level	VI-5
	C. Production Effects	
	1. Potential Plant Closures	VI-7
	2. Sensitivity Analysis	VI-11
	D. Employment Effects	VI-11
	E. Community Effects	VI-13
	F. Balance of Payments Effects	VI-13
VII.	LIMITS TO ANALYSIS	VII-1
	A. General Accuracy	VII-1
	B. Possible Range of Error	VII-1
	C. New Technology	VII-2
	D. Critical Assumptions	VII-2
	E. Remaining Questions	VII-3

EXECUTIVE SUMMARY

I. INDUSTRY SEGMENTS

This study analyzes the potential economic impact of the discharge water effluent controls determined by EPA on the Cane Sugar Refining industry, SIC 2062. Although the study makes comparative and illustrative reference to the cane sugar growing and milling industries, these industries are not central to the study's impact analysis.

A. Types of Firms

1. Size of Firms

Cane sugar industry firms vary from small individual mills and refineries to major diversified U.S. corporations. The twenty largest firms account for 77 percent of the refining industry's capacity and 37 percent of the sugar milling capacity.

2. Level of Integration

Two cane sugar firms have diversified into corn and beet sweeteners and there is some degree of vertical integration between growers and milling operators and milling and refining operators within the cane sugar industry. Puerto Rican operations, largely controlled by the Commonwealth of Puerto Rico, show frequent integration from growing to refining. Five Hawaiian companies control the state's nineteen mills and much of its cane fields and, in turn, through their cooperative operation of the C&H Company, refine and market their sugar products. In Florida 130 cane farms are owned by mills which account for 90 percent of the state's raw sugar production. Louisiana is an area of extensive independent ownership of both cane growing and cane milling operations. In summary, 68 percent of all U.S. sugar cane is produced on mill-owned farms and 23 percent of all refined cane sugar is processed in a refinery which is integrated with milling operations.

3. Number of Plants

The overall cane sugar industry is composed of:

6,373 cane farms
79 cane mills, and
29 refineries.

4. Products

The refined cane sugar industry produces essentially but one major product, refined cane sugar--crystalline sucrose. Marketed in a variety of packaging units (the 100 pound bulk bag is more frequent), the sugar is processed into varying degrees of color, fineness, and concentration. Some small percentages are sold as liquid sugar.

5. Level of Diversification

The twenty largest firms in the industry are diversified corporations, and with the exception of Amstar, all have sugar refining as a relatively minor part of their operations. Small industry firms generally derive their sales primarily from cane sugar production and processing.

B. Refinery Characteristics

1. Size and Age

Refineries, unlike mills whose operations are seasonal, operate throughout the year. The nine industry refineries whose capacities are 1,500 tons of raw sugar per day or greater account for 58 percent of the total U.S. capacity. Except for three plants, all refineries are over 50 years old. All are well maintained and technologically up-to-date.

2. Location

Refineries generally locate near deep water ports to benefit from the resulting bulk shipping rates allowed by the shipping requirements of raw sugar and within major population centers to achieve freight economies in the transporting of refined sugars.

A locational characteristic important to this study is the fact that the older refineries may find that acquiring additional and adjacent land for effluent disposal is exceedingly costly because they are located in heavily industrialized areas. Newer and less industrialized area plants will not be similarly affected.

3. Level of Technology and Efficiency

Refineries are capital intensive. Approximately 12,000 employees refine all domestic and imported raw sugar (c.f. 15,000 milling employees produce but one-third of the refineries' raw sugar inputs).

Industry plants may be technologically classified into:

14 crystalline refineries
5 liquid sugar refineries
2 liquid-crystalline refineries, and
8 refineries operating with mills.

Seventy-four percent of the industry's refined sugar is processed through a similar procedure. Refineries receive raw sugar from cane mills and extract its major impurities through affination and melting and further impurities through filtering, clarification and decolorization processes. The sugar is, in turn, evaporated and crystallized in single effect, batch evaporators called vacuum pans. Final processing steps are drying and screening.

Four plants, representing 7 percent of the industry's capacity, are liquid sugar refineries. Their processes are essentially similar to those producing crystal sugar except that such plants, because they do not use vacuum pans for crystallization, use considerably less condenser water and process steam.

C. Number of Plants and Employment by Segment

Sugar refineries are, as previously indicated, capital intensive. Increasing efficiency and production have reduced employment from the 1968 number of 13,049 to 12,240 in 1972. Sugar refineries average 237 employees per 1,000 tons per day capacity.

II. FINANCIAL PROFILE

A. Plants by Segement

The model plant financial data used in this analysis were based upon the economic contractor's primary research among industry sources representative of the cane sugar refining industry. Four model plants, each representing a group of operating refineries, have been constructed, as follows:

Type	Location	Capacity (tons/day)	No. Operating Plants
Liquid	Urban	500	5
Crystalline	Rural	400	8
Crystalline	Rural	1,200	4
Crystalline	Urban	2,000	12

1. Annual Profit

The industry is characterized by low returns; indeed, industry profits show a significant decline between 1971 and 1973, with some companies incurring losses. The model plant configurations show losses essentially for small, rural refineries only (generally Puerto Rican refineries). Generally, losses are a reflection primarily of management practices rather than of intrinsic plant characteristics. Returns on estimated book investment range from a negative 4.5 percent for small rural Puerto Rican refineries to a positive 3.7 percent for liquid refineries.

2. Annual Cash Flows

Positive cash flows are characteristic of all model plant configurations.

3. Market (Salvage) Value of Assets

Liquid sugar refineries, because their processing is less complex, require a lower capital investment than do other plants. Although most industry plants are fifty years old, modernization has kept their machinery and equipment current. Land values, based upon original purchase prices, are considered as book prices (i.e., lower than replacement values). Generally, depreciable assets are approximately one-third of total investment, with recovery estimated at 10 percent of book. Net working capital and land are fully recoverable.

B. Cost Structure and Relationship of Financial Data to Plant Size and Location

Although the model plants' cost structure reflects variations in both returns and costs between liquid and crystalline sugar refineries and urban and rural refineries, the model plant configurations generally indicate that little intrinsic causal relationships exist between a refinery's cost and returns and its size or location. Profit and loss, rather, are indicative of plant management practices.

C. Ability to Finance New Investment

An analysis of the financial data for three specific and representative industry companies (Amstar, Sucrest, and Savannah) shows that industry companies are generally able to fund new investments. The least profitable, Sucrest, with a low profit margin and earnings of approximately 1 percent on sales and 5 percent to 6 percent on equity, nevertheless, financed capital expenditures of from $1.4 to $3.1 million during the 1968 through 1972 period. The long-term debt profiles of these companies also indicate that pollution controls will not present insuperable investment requirement. Doubtless, for small, marginal plants, the availability of investment funds will not be the sole criterion for investment decisions. In some cases, investment funds might be more profitably expressed elsewhere.

III. PRICING

A. Price Determination

1. Demand

U.S. per capita sugar consumption has been relatively constant at between 90 and 100 pounds since the 1930's, and approximately two-thirds of this is absorbed by industrial users, especially the food processing industry. Additionally, one-fourth is purchased for home use; the remainder is used by restaurants and institutional food preparers.

Among industrial food processors, the beverage industry is the heaviest user of sugar and noncaloric sweeteners (cyclamate and saccharine), followed by the baking industry, confectionary users and the canning industry. Sugar's proportion of these industries' use of sweeteners has declined slightly in the past two decades to indicate that sugar demand is affected by the quality, price, and availability of product substitutes (i.e., corn syrups and noncaloric sweeteners).

The substitution of noncaloric sweeteners is relatively unreflective of price considerations. Corn syrup, sugar's major competitor, has traditionally been a limited substitute product because of its quality characteristics; however, recent technological processes have enhanced those quality characteristics and offer promise of reduced costs. Corn syrup may increasingly gain a share of the sugar market although such increased use will require significant investment and an intensive consumer acceptance program. In many instances, too, such increased use will require the modification of those FDA regulations governing the use of corn syrups.

Data are not available on the price elasticity and cross elasticity of demand for the industrial use of sugar. Some price consciousness is apparent as the cost of sugar increases in proportion to total food costs. Demand, then, appears increasingly elastic in the long run. In the household use segment of the market, demand is highly inelastic; sugar's share of household budgets is too low for the product's use to be significantly affected by product price or by income levels.

2. Government Sugar Policy

The sugar industry has been protected by the federal government since 1789. Under modern quota controls sugar imports and distribution are regulated (under the U.S. Sugar Act of 1948 and as subsequently amended) through (1) limiting the available supplies, (2) providing U.S. cane and beet sugar grower subsidies, (3) placing excise taxes on all sugar marketed within the U.S., and (4) imposing tariffs on sugar imports.

In brief, under the provisions of various sugar marketing authorizations the Secretary of Agriculture is responsible for the adjusting of imports and the allocating of regional supplies in order to maintain product pricing objectives. Such provisions are germane to the present study to the extent that they affect product prices subsequent to the imposition of effluent controls on the sugar industry. For example, should effluent control costs result in the closing of sugar mills and a consequent loss of sugar cane production, the Secretary of Agriculture is required to distribute the lost production to other domestic quota areas first and then to import quotas. If such reallocation were not made, the resulting sugar shortage would increase wholesale prices and cause refiners to bid the cost of raw sugar to levels exceeding the statutory price objectives.

3. Base Point Pricing

Base point pricing developed because large refineries found it advantageous to locate close to ports of entry and-or adjacent to major population centers, and as a result, these refineries became the major sellers and base point price determiners in their respective areas. In the eight base point pricing regions of the U.S., price is calculated as the price of the point of origin plus the freight costs from point of origin to buyer's location. The principal seller in each region sets prices in order to maximize his regional profits.

4. Supplies

Forty-five percent of the U.S. sugar is imported; 26 percent is supplied by domestic sugar cane; 29 percent is supplies by domestic sugar beet production.

B. Expected Price Impacts

The cane sugar refining industry will find it difficult to pass through the costs of increased effluent controls. The availability of product substitutes and the price stability consequent to federal price controls make it doubtful that significant price increases can be achieved in the long run.

Ultimately, the industry's ability to pass through price increase will depend upon government sugar policy. Supply curtailment in the cane mill industry could mean price increases to refiners and consumers if quotas were not adjusted accordingly and if world sugar prices remained at present levels. Apparently, much of any projected price effects will depend upon the impact of pollution controls on cane mill production.

IV. ECONOMIC IMPACT ANALYSIS METHODOLOGY

A. Fundamental Methodology

The economic impact analysis utilizes the basic data developed on industry segments, financial profiles and price effects, together with pollution abatement technology and costs developed by EPA. Impacts analyzed include:

* Price effects
* Financial effects
* Production effects
* Employment effects
* Community effects
* Foreign trade effects

The determining force of plant shutdowns on these impacts is crucial; consequently, the financial and production effects which would most immediately reflect plant shutdowns, were given most emphasis in this analysis.

In general, the approach used can simply be stated as the problem of deciding whether a commitment of time or money to a project is worthwhile in terms of the expected benefits. The primary factors involved in assessing the financial and production impact of pollution control are profitability changes and these, in turn, are a function of the cost of pollution control and the ability to pass along these costs as higher prices. In reality, of course, closure decisions are seldom made on the basis of well-defined economic rules. Such decisions invariably include a wide range of personal values, external forces such as the ability to obtain financing, or the role of the the production unit in an integrated larger cost center.

However, the analysis was made on the premise that the economic returns in the industry would be the primary determinants of plant closures. In the most fundamental case, a plant will close when variable expenses (Vc) are greater than revenues (R). A more probable situation is the case in which $Vc < R$, but revenues are less than variable costs plus fixed, short-run cash overhead expenses (TC_c). In this situation, a plant would likely continue to operate in the short-run but would be forced out over a longer period of time. Necessary to such a situation is the firm's expectation that revenues will increase to cover total cash outlay. Identification of plants where $TC_c > R$ but $Vc < R$ leads to an estimate of plants that should eventually close if revenues do not increase.

The next level of analysis, where TCc < R, involves estimating the earnings before and after investment in pollution abatement. Under conditions in which TCc < R, it seems likely that investment in pollution control will be made and that plant operations will continue so long as the capitalized value of earnings (CV) is greater than the salvage value of the sunk investment of the plant. Computation of CV involves discounting the future earnings flow to the present worth. Discounted internal rates of return (the computed discount rate, or yield, which produces a zero present value of the cash flow) was the measure of profitability used. These rates of return, with and without pollution controls and the estimated salvage values of plant, equipment and land were the major factors used to determine potential plant shutdowns.

B. Price Effects

In order to provide a standard to reflect price effects, an estimated price adjustment sufficient to offset required pollution control costs was calculated. Application of the discounted cash flow procedure to pollution control costs yields present values and from this the price increase required to pay for pollution control was calculated by the formula:

$$X = \frac{PVP(100)}{(1-T)(PVR)}$$

where:
- X = required percentage increase in price
- PVP = present value of pollution control costs
- PVR = present value of gross revenue starting in the year pollution control is imposed
- T = tax rate

C. Production Effects

A study of the technological characteristics of the industry and of industry production practices underlay the analysis of probable changes in plant capacity utilization and in the industry's ability to absorb capacity losses as marginally productive plants are closed. Model plant data were equated with those from actual industry plants (under "with" and "without" pollution control conditions) to arrive at the estimated probability of closure results.

D. Employment Effects

Given the production effects of estimated production curtailments, of plant closings, and of changes in industry growth, employment effects were estimated on the basis of known production-employment relationships.

V. POLLUTION CONTROL REQUIREMENTS AND COSTS

This analysis of the economic impacts of water pollution controls on the cane sugar refinery industry is based upon the control standards, technology, and costs which were provided the contractor by the Environmental Protection Agency.

A. Alternative Effluent Control Levels

Five levels of effluent control technologies were defined by EPA:

1. Alternative A: No waste treatment
2. Alternative B: Elimination of discharge from filters
3. Alternative C: In-plant modifications to reduce the entrainment of sucrose in condenser water
4. Alternative D: Biological treatment of waste water
5. Alternative E: Recyclining of condenser water and biologically treating blowdown

These alternative technologies, varying in cost and in their degree of applicability to crystalline and liquid cane sugar refineries, offer appropriate control measures to achieve the effluent discharge levels needed to comply with the EPA control standards.

Of the 29 operating refineries, sixteen either employ sufficient controls or discharge their waste waters into municipal treatment facilities. A major determinant of the level of increased pollution control costs will be the treatment of the refineries' condenser water: only five plants adequately treat such water or discharge it to municipal treatment facilities and fourteen plants discharge it after but one pass through the condenser.

B. Water Pollution Abatement Costs

The EPA estimates of present technology, required modification, and eventual costs indicate that the cane sugar refining industry will incur significant costs in reaching the effluent control standards required in 1977 (BPT standards) and in 1983 (BAT standards). Additionally, the industry will also realize appreciable operating and maintenance costs to operate the control systems.

The overall industry investment costs for BPT levels of treatment are $5,228,000, and an additional $10,817,000 will be required to meet BAT standards. BPT investment ranges from $56,000 to $782,000 for individual plants, while BAT investment range from $28,000 to $766,000 per plant. Annual industry operating costs for BPT level controls are $1,656,000, while BAT annual industry costs are $1,600,000. Annual BPT costs range from $20,300 to $184,100 per plant, with annual BAT costs ranging from $1,500 to $113,400. Of the industry's twenty-nine refineries, seventeen will require additional investment by 1977. Twenty-two plants will require such investment by 1983.

VI. IMPACT ANALYSIS

This economic impact analysis considered the following impacts:

Price
Financial
Production
Employment
Community
Balance of Payments

Emphasis was given to the consideration of the financial and plant closure analysis.

A. Price Effects

The estimated price increases for the industry refineries to maintain their current levels of profitability are modest and except for the "small, rural" plant segment, all industry plant categories require less than a one percent increase in current prices. Eleven percent of the industry plants operate under effluent discharge levels which require no additional technology.

As has been previously discussed in Chapter III, the demand for household sugar use is highly inelastic; the required price increase will not significantly alter consumption levels. Industrial use, because it is influenced by the relative pricing of sugar substitutes, will probably reflect some although not critical, demand shifts. Ultimately, then, the effect of a potential increase in prices is largely dependent upon the influence exerted over prices and competition by the Secretary of Agriculture acting under the provision of the Sugar Act. As was shown also in Chapter III the Act's provisions allow for a variety of actions to either protect the industry from competitive pressures or to stimulate lower consumer prices. Although the market conditions and the increasing emphasis on lower consumer prices make dependable assumptions near arbitrary at best, the present study assumes that compensatory product price increases are not likely under current conditons. The following analysis, therefore, assumes that price increases will not take place.

B. Financial Effects

This study's estimates of the financial effects of pollution control costs reflect the financial characteristics of the industry model plants (Chapter II) and the incremental costs to such plants as previously noted (Chapter V). In addition, estimates are based upon a discounted cash flow procedure and assume no price increases.

1. Profitability

As shown in Chapter II, the cane sugar refinery industry is not highly profitable with after-tax returns on invested capital from a negative 4.5 percent to a positive 3.7 percent.

Approximately 30 percent of the total capacity of the industry will be impacted by BPT and BAT control level costs. Furthermore, the impact of condenser water treatment control implementation will be felt by all refineries and the annual operation and maintenance costs of these facilities are significant enough to markedly effect current net values.

The discounted cash flow analysis, assuming a 6.5 percent and a 7.5 percent discount rate (the approximate after-tax cost of capital for the industry), applied for both the BPT and the BAT control level costs, indicated that, depending upon the specific industry plants, the net present values of a targeted discounted cash flow of 6.5 percent could drop from $3,949,000 before control costs to negative amounts after the imposition of controls.

C. Production Effects

The potential production effects projected by the present study were estimated by comparing "shutdown" model plant characteristics to those of industry firms.

Obviously, plant closures will not be arbitrarily determined by industry companies, for such decisions will reflect numerous non-quantifiable determinants (Chapter IV). This study considered, in projecting plant closures, such variables as plant size, corporate structure, location, and market advantage. Based upon such considerations, the analysis concluded that of the twenty-nine industry plants:

- 24 would have impacts not considerable enough to indicate closure
- 3 would have impacts considerable enough to indicate probable closure
- 2 would have impacts considerable enough to indicate a possibility of closure.

Thus, 80 percent of the plants with 89 percent of industry capacity will continue operations; 7 percent of the plants with 5 percent of industry capacity will become marginal; and 10 percent of the industry plants with 6 percent of industry capacity will face probable closure.

D. Community Effects

The effect upon a community of a plant's closing is proportional to that plant's economic role in the community's life. In small, rural community's whose economic life is considerably dependent upon a cane sugar refinery, that impact may be extensive and especially so when the refinery is supportive also of area sugar cane growers and sugar cane mills. The closure analysis suggests that from three to five small communities may be so affected.

E. Balance of Payments Effects

The loss of from six to eleven percent of industry production will obviously be felt to the degree that such production utilized imported raw sugar and resulted in refined sugar exportation. Too, the effect of such production losses will be affected by the increased use of beet sugar, corn syrup, or noncaloric substitutes. Of great significance, too, in determining the effect on balance of payments from such losses will be the compensatory actions of the Secretary of Agriculture. Such variables are too problematic to justify accurate projections given this study's contract limitations.

VII. LIMITS OF THE ANALYSIS

Financial and production information reflecting investments, operations, costs, and returns was not definitively available for individual plants or firms. As a reuslt, the impact anlaysis was, of necessity, based on synthesized costs and returns for representative types and sizes of model plants. These data were developed from a variety of sources including published secondary research from universities and government agencies, previous studies done by the contractor, information obtained from operating firms in the sweetener industries, published financial performance data, and discussions with industry consultants and other knowledgeable individuals.

Throughout the study, an effort was made to evaluate the data and other information used and to update these materials wherever possible. Checks were made with informed sources in both industry and government to help insure that the data and other information used were as reliable and as representative as possible.

Water pollution control costs and technology data were furnished by EPA, Effluent Guidelines Division. These costs were developed for five "typical" refineries as described earlier in this report. It was necessary to adapt these costs to the types and sizes of plants discussed in this analysis. This adaption process required the making of assumptions and adjustments related to these data which are critical to the impact analysis. In addition, it was necessary to make specific assumptions regarding the current status of effluent disposal and treatment in the sugar refinery industry. These assumptions are described in detail in the "Critical Assumptions" section of this report. The validity of these assumptions and of the effluent control costs which result introduce an additional element of uncertainty and possible inaccuracy.

However, assuming the accuracy of the study's data, it is believed that the analysis represents a usefully accurate evaluation of the economic impact of the proposed effluent guidelines on the cane sugar refinery industry.

I. INDUSTRY SEGMENTS

This study analyzes the potential economic impact of the effluent controls proposed by EPA on the Cane Sugar Refining industry, SIC 2062. Although the study makes comparative reference to cane sugar growing and milling, these industry functions are not central to the study's inpact analysis.

A. Types of Firms

1. Size of Firms

Cane sugar industry firms vary from small individual mills and refineries to major U.S. corporations. Table I-1 lists the 20 large firms that dominate the cane sugar industry. Amstar, by virtue of its five cane sugar refineries and its ownership of Spreckels, a beet sugar company based in California, is the leading producer. Spreckels has approximately 12 percent of the U.S. beet capacity, and this subsidiary has also acquired a wet corn milling company. Therefore Amstar is involved in three phases of the sugar processing industry. Twenty large companies have 80 percent of the refining capacity and 37 percent of the sugar cane milling capacity. The geographic distribution of the 29 refineries is shown in Table I-2. The largest concentration is on the East Coast, near the major markets. The companies operating refineries are shown in Table I-3, with percent of U.S. refining capacity.

2. Level of Integration

Table I-1 shows industry diversification into other sweeteners and Tables I-4 and I-5 indicate some degree of vertical integration between growers and milling operations and milling and refining operations. In a few instances, integration extends from growing, through milling, into refining. Tables I-4 and I-5 indicate that Puerto Rico's are essentially integrated operations. The areas refineries are either owned or subsidized by the Puerto Rican Commonwealth. Although there are many small farms, the growers are closely tied to the mills.

Essentially five companies own the 20 Hawaiian mills expected to be operating in 1973, and, with the exception of 500 cane growers that have varying degrees of tie-in with the mills, the cane land is owned by the processing mill companies. These companies own the refinery operations of C&H in Hawaii and on the mainland near San Francisco. All of the marketing of sugar is done through C&H.

Although Florida has but one mill that is vertically integrated from growing to refining (accounting for seven percent of the Florida raw sugar production), all other Florida mills are land owners; therefore, the state's 130 farms are mill owned and account for 90 percent of the state's raw sugar production.

Table I-1. Dominant cane sugar firms and relation to industry

	Firms	Estimated Net Worth	Other Sweeteners		Cane Sugar							
						Mills			Refineries			
			Corn	Beet	Grower	No.	TPD	Pct 1/	No.	TPD	Pct 1/
		($ million)										
1.	Amstar	175	X	X					5	11,050	
2.	C & H	NA							2	3,690	
3.	Borden, Inc.	725							3	2,190	
4.	Su Crest Corp.	20							2	1,670	
5.	Archer Daniels Midland	124							1	700	
6.	CPC International	510	X						1	1,800	
7.	United Brands	494							1	1,200	
8.	Savannah Foods	32							2	2,550	
9.	Imperial Sugar	NA							1	1,500	
10.	Zapata-Narness	NA			X	4	14,400		1	660	
11.	U.S. Sugar Co.	55			X	2	22,000				
12.	Gulf & Western Foods	673			X	1	8,000				
13.	Southdown Lands	132			X	3	10,900				
14.	Jim Walters Co.	345			X	1	4,000				
15.	Alexander Baldwin Ltd.	143			X	4	15,100				
16.	Amfac	210			X	5	19,050	2/			
17.	C. Brewer & Co.	90			X	7	14,260	2/			
18.	Theo H. Davis	NA			X	2	5,700	2/			
19.	Castle & Cooke Inc.	224			X	2	7,400	2/			
20.	Pepsico	440							1	800	
	Subtotal					31	120,810	37	20	27,810	80
	Other Companies - U.S.					37	154,065	47	4	5,060	15
	Other Companies - Puerto Rican					11	55,050	17	5	1,820	5
	Total Domestic Cane Sugar Industry					79	329,925	100	29	34,690	100

1/ Percent columns may not add due to rounding.

2/ Net tons per day. All other capacities stated as gross tons per day.

Table I-2. Number of cane sugar refinery companies, owners and refineries by geographic area

Location	Number of Companies and Owners 1/	Number of Refineries
Louisiana	6	6
Puerto Rico	5	5
Hawaii	1	1
Florida	3	3
West Coast	1	1
East Coast	8	10
Texas	1	1
Midwest	2	2

1/ Include multi-regional owners.

Table I-3. Domestic Cane Sugar Refineries

Percent of Industry Capacity	Company	Location
31.9	Amstar Corporation	Brooklyn, N.Y. Boston, Mass. Baltimore, Md. New Orleans, La. Philadelphia, Pa.
10.6	California & Hawaiian Sugar Co.	Crockett, Calif. Aiea, Hawaii
6.3	Borden Inc. North American Sugar Industries Inc. Colonial Sugars Co. Florida Sugar Refinery, Inc. Industrial Sugars, Inc.	 Gramercy, La. Belle Glade, Fla. St. Louis, Mo.
7.4	Savannah Foods & Industries, Inc. Everglades Sugar Refinery Inc.	Savannah, Ga. Clewiston, Fla.
1.3	Glades County Sugar Grower Coop. Assn.	Moore Haven, Fla.
4.9	Godchaux - Henderson Sugar Co.	Reserve, La.
4.3	Imperial Sugar Co.	Sugarland, Texas
5.8	National Sugar Refining Co.	Philadelphia, Pa.
2.3	Pepsico Inc.	Long Island City, N.Y.
3.5	United Brands Revere Sugar Refinery	 Charlestown, Mass.
2.0	Jim Walter Company The South Coast Corporation	 Mathews, La.
5.2	CPC International Refined Syrups and Sugars, Inc.	 Yonkers, N.Y.
1.9	Zapata - Norness Southdown, Inc.	 Houma, La.
4.8	SuCrest Corporation	Brooklyn, N. Y. Chicago, Illinois
2.0	Archer Daniels Midland Supreme Sugar Refinery	 Supreme, La.
5.2	Refineries of Puerto Rico (5)	Puerto Rico

Table I-4. Cane sugar processing integration relationship, grower-mill integration, 1971 production

	Louisiana		Florida		Hawaii		Puerto Rico		Total	
	Production	Pct	Production	Pct	Production	Pct	Production	Pct	Production	Pct
Total Cane (000 acres)	301	34	194	22	232[1/]	26	153	18	880	100
Total Cane (000 tons)	7,974	25	6,388	20	10,685	34	6,437	21	31,484	100
No. of Farms	1,513		130		528		4,202		6,373	
Total Raw Sugar (000 tons)	571	20	635	23	1,229	45	324	12	2,759	100
Total Mills	43		8		26		16		93	
Grower-Mill Integration										
Co-op Mills	8		3		4		0		15	
Administration Cane (000 tons)	2,536	86	2,127	99	914	70	0		5,577	87
Independent Cane (000 tons)	417	14	11	1	391	30	0		819	13
Total Cane	2,953		2,138		1,305		0		6,396	
Corporation Mills	35		5		22		0		62	
Administration Cane (000 tons)	1,663	33	3,630	85	8,911	95	0		14,204	76
Independent Cane (000 tons)	3,358	67	620	15	469	5	0		4,447	24
Total Cane (000 tons)	5,021		4,250		9,380		0		18,651	
Government Mills	0		0		0		16		16	
Administration Cane (000 tons)	0		0		0		1,568	24	1,568	24
Independent Cane (000 tons)	0		0		0		4,869	76	4,869	76
Total Cane (000 tons)	0		0		0		6,437		6,437	
Total Administration Cane (000 tons)	4,199	53	5,757	90	9,825	92	1,568	24	21,349	68
Total Independent Cane (000 tons)	3,775	47	631	10	860	8	4,869	76	10,135	32
Total Cane (000 tons)	7,974		6,388		10,685		6,437		31,484	

[1/] Total cane acreage - only 1/2 harvested each year due to 22-24 month crop maturity.

Sources: Hawaiian Sugar Planter's Association Sugar Manual, 1973
Gilmore Sugar Manual 1971
USDA -ASCS various data
Puerto Rico Land Administration Data

Table I-5. Cane sugar processing integration relationship, mill-refinery integration, 1971 production

	Louisiana		Florida		Hawaii		Puerto Rico		Total	
	Production	Pct	Production	Pct	Production	Pct	Production	Pct	Production	Pct
Total Cane (000 acres)	301	34	194	22	232 [1/]	26	153	18	880	100
Total Cane (000 tons)	7,974	25	6,388	20	10,685	34	6,437	21	31,484	100
No. of Farms	1,513		130		528		4,202		6,373	
Total Raw Sugar (000 tons)	571	20	635	23	1,229	45	324	12	2,759	100
Total Mills	43		8		26		16		86	
Mill-Refinery Integration										
Integrated Mill										
Raw Sugar (000 tons)	8		1		26		16		44	
	124	22	46	7	1,229	100	324	100	1,723	62
Non Integrated Mill										
Raw Sugar (000 tons)	35		7		0		0		42	
Total Raw Sugar	447	78	589	93	0	0	0		1,036	38
	571		635		1,229		324		2,759	

1/ Total cane acreage - only 1/2 harvested each year due to 22-24 month crop maturity.

Sources: Hawaiian Sugar Planter's Assn. Sugar Manual, 1972.
Gilmore Sugar Manual 1971
USDA-ASCS Various data
Puerto Rico Land Administration Data

Louisiana has the only area of extensive independent ownership of both cane farm and milling operations. Definitive acreage data are not available but approximately half of the state's production is from independent growers and independently owned mills. Seven of the mills owned by three companies are vertically integrated through the three operations of the cane sugar industry.

Table I-4 indicates that 68 percent of all sugar cane is produced on mill-owned farms. Table I-6 shows that 23 percent of all refined cane sugar is processed in a refinery that is integrated with a milling operation.

3. Number of Plants

The overall cane sugar industry is composed of:

6,373 cane farms,
79 cane mills, and
29 refineries

4. Products

Although the cane sugar refining industry processes a variety of product forms, its essential product is refined cane sugar - crystalline sucrose. (Some small percentage of sugar is produced in liquid form.) Crystalline sugar is refined into varying degrees of color, fineness and concentrations and is packaged in bulk, in 100 pound bags, or in various consumer package sizes. The prevalent product is white cane sugar, priced and sold in 100 bag units.

5. Level of Diversification

As Table I-1 shows, the industry's large companies are diversified firms; indeed, cane sugar processing with few exceptions, is a minor part of the 20 large companies' sales. The notable exception is Amstar which has approximately 60 percent of its inventory in some form of cane sugar and, presumably, its sales and assets assume a similar proportion.

Other smaller companies generally derive their sales primarily from cane sugar production and processing.

B. Refinery Characteristics

The cane sugar industry is composed, on the whole, of farms or plantations, mills and refineries. This study is directly concerned with refineries only, and these may be categorized by size, location, and output.

Table I-6. Refinery-mill integration by company and relationship to total industry

Refineries integrated	Capacity	No. of Refineries	Percent of Capacity
C & H	3,690	2	10.6
Glades County Coop.	460	1	1.3
South Coast	700	1	2.0
Southdown	660	1	1.9
Supreme	700	1	2.0
Puerto Rico	1,820	5	5.2
Integrated Refinery Total	8,030	11	23.0
Non Integrated Total	26,660	18	77.0
Total - All Refineries	34,690	29	100.0

1. Size

Unlike mills which operate only during the cane harvest season, refineries operate year-round. Table I-7 indicates, by company, the industry's raw sugar capacity (approximately 97 percent pure sugar).

The larger refineries are located in large population centers, and the nine refineries that have a capacity of over 1,500 tons per day account for 61 percent of the total U.S. refining capacity.

With the exception of three plants, all of the refineries are over 50 years old, are well maintained, and are technologically up-to-date. Except where noted in the following section, age is not a significant differentiation characteristic among plants.

2. Location

As Table I-7 and Figure I-1 indicate, refineries are located at deep water ports (for the shipping of domestic and imported raw sugar) and in close proximity to population center markets. These location factors reflect the industry's transportation requirements. Because raw sugar is not classified as a food product and may be shipped as bulk cargo, refineries have long employed deep-water, dockside facilities. Refined sugar, on the other hand, is classified as a food, and its transport is more costly because of its higher value and its required sanitation.

To the extent that effluent control requirements will necessitate a refinery's using additional land for effluent disposal, the economic cost of land adjacent to the refinery may be great in heavily industrialized areas. This may be less true of new plants and rural plants (Table I-7).

Though the Chicago and St. Louis refineries are not deep water port locations, they both realize the relatively lower costs of water transport. The Chicago refinery's access to the Great Lakes makes it an international port. The St. Louis refinery's raw sugar is barged on the Mississippi River.

3. Level of Technology and Efficiency

The cane production and harvesting segment of the industry is essentially agricultural, and it employs primarily unskilled labor. The harvesting and loading operation are becoming increasingly mechanized, but the equipment is not sophisticated.

Refining is more capital intensive than milling: Fewer than 12,000 men refine all domestic and imported raw sugar; milling requires 15,000 employees to produce only one-third of the amount of raw sugar the refineries process.

As Table I-8 indicates, industry plants may be technologically classified into:

Table I-7. United States cane sugar refinery companies, location and capacity

No.	Company Name	Refinery Location	Capacity	Total Daily Capacity
Liquid refineries			(TPD)	(Pct.)
1	SuCrest	Chicago, Illinois	850	
2	Pepsico	Long Island City, N. Y.	800	
3	Industrial	St. Louis, Missouri	300	
4	Florida Sugar	Belle Glade, Florida	390	
5	Ponce Candy	Ponce, Puerto Rico	100	
			2,440	7
Rural: Small crystalline refineries - 700 tons/day or less				
1	Glades Co. Cooperative	Moore Haven, Florida	460	
2	C & H	Aiea, Hawaii	190	
3	Puerto Rico Land Administration	Guanica, Puerto Rico	220	
4	Puerto Rico Land Administration	Humacao, Puerto Rico	400	
5	Everglades	Clewiston, Florida	350	
6	Southdown	Houma, Louisiana	660	
7	Puerto Rico Land Administration	Mercedita, Puerto Rico	600	
8	Puerto Rico Land Administration	Igualdad, Puerto Rico	700	
			3,580	10
Large crystalline refineries - over 700 tons/day				
1	J. Aron	Supreme, Louisiana	700	
2	Colonial	Gramercy, Louisiana	1,500	
3	South Coast	Mathews, Louisiana	700	
4	Godchaux	Reserve, Louisiana	1,700	
			4,600	13

(continued)

Table I-7. (Continued)

No.	Company Name	Refinery Location	Capacity (TPD)	Total Daily Capacity (Pct.)
Urban: Crystalline refineries				
1	Amstar	Baltimore, Maryland	2,600	
	"	Brooklyn, New York	2,100	
	"	Chalmette, Louisiana	3,250	
	"	Philadelphia, Pennsylvania	2,100	
	"	Boston, Massachusetts	1,000	
2	Imperial	Sugarland, Texas	1,500	
3	CPC	Yonkers, New York	1,800	
4	National	Philadelphia, Pennsylvania	2,000	
5	Savannah	Port Wentworth, Georgia	2,200	
6	Revere	Charlestown, Massachusetts	1,200	
7	SuCrest	Brooklyn, New York	820	
8	C & H	Crockett, California	3,500	
			24,070	70
U. S. Total companies (24)		Total Daily Capacity	34,690	100

Figure I-1. Location of mainland cane sugar refineries.

Table I-8. Cane sugar refineries by type and capacity

Refinery - Type and Company	Location	Percent of total domestic capacity
Crystalline Refineries		
1. Amstar	Baltimore, Md.	
2. Amstar	Boston, Mass.	
3. Amstar	Brooklyn, N. Y.	
4. Amstar	Chalmette, La.	
5. Amstar	Philadelphia, Penn.	
6. California & Hawaiian	Crockett, Calif.	
7. California & Hawaiian	Aiea, Hawaii	
8. Colonial (Borden)	Gramercy, La.	
9. Everglade(Savannah Foods)	Clewiston, Fla.	
10. Godchaux	Reserve, La.	
11. Imperial	Sugarland, Texas	
12. National	Philadelphia, Penn.	
13. Revere	Charlestown, Mass.	
14. Savannah Foods	Port Wentworth, Ga.	74
Liquid Sugar Refineries		
1. Florida Sugar (Borden)	Belle Glade, Fla.	
2. Industrial (Borden)	St. Louis, Mo.	
3. Pepsico	Long Island, N. Y.	
4. SuCrest	Chicago, Ill.	7
5. Ponce Candy	Puerto Rico	
Liquid-Crystalline Refineries		
1. CPC	Yonkers, N. Y.	
2. SuCrest	Brooklyn, N. Y.	8
Refineries Operating with Sugar Mills		
1. Glades County	Moorehaven, Fla	
2. Guanica	Ensenada, P. R.	
3. Iqualdad	Mayaquez, P. R.	
4. J. Aron & Company	Supreme, La.	
5. Mercedita	Ponce, P. R.	
6. Roig	Yubacoa, P. R.	
7. South Coast	Mathews, La.	
8. Southdown	Houma, La.	11

14 crystalline refineries
5 liquid sugar refineries
2 liquid-crystalline refineries, and
8 refineries operating with mills

Seventy-four percent of the industry's refined sugar is produced under the process described below.

The raw material for cane sugar refining is crystalline sugar produced by the cane sugar mills. Raw sugar crystals have a film of molasses in which the non-sucrose components are concentrated. The thickness of the films is dependent upon the purity of the sugar.

A cane sugar refinery receives raw sugar in bulk form by truck, rail, barge, and/or ship, and stores it for periods up to several months in large warehouses. Aside from the extent of the impurities present, there is little difference between raw sugar produced from domestic or imported cane.

Affination and Melting [1/] -- The first step in the refining process requires the placing of raw crystals into a syrup solution. The resulting magma is fed into centrifugals which separate the syrup and molasses from the sugar. Hot water added for washing and the washed sugar is then discharged into a melter containing about one-half of the sugar's weight in water.

Clarification (Defecation) -- The screened, melted liquor contains fine suspended and colloidal matter which is removed through clarification, a process which may involve coagulation and floatation clarifiers or a pressure filtration system.

Decolorization -- After affination and clarification, impurities and color remaining in the sugar liquor are removed by physical adsorption. Most large crystalline refineries use fixed-bed, bone char cisterns (also called filters) for this processing.

The sugar liquor passes in a parallel gravity flow through each cistern and undergoes adsorption of the color bodies and ions. From 90 to 99 percent of the color is removed, mostly at the beginning of the cycle. (Powdered activated carbon is used for decolorization in small refineries and in liquid sugar production. Because the generation of powdered carbon is difficult, it is normally discarded after one or two cycles; however, in 1972, one company announced the successful and economical regeneration of powdered activated carbon.)

Evaporation -- No matter what method of decolorization is used, the final steps of recrystallizing and granulating are essentially the same in all refineries. The first step in recrystallization may be the concentrating

1/ Process description adapted from Development Document for Effluent Limitations Guidelines. Environmental Protection Agency, March 1974.

of the decolorized sugar liquor and sweet waters in continuous type evaporators. Since these liquors are kept as highly concentrated as possible, refinery pans are relatively small compared to the evaporators used in raw sugar mills.

Crystallization -- After concentration in evaporators, the sugar liquor and sweet waters are crystallized in single effect, batch type evaporators called vacuum pans. Several pans are used exclusively for commercial granulated sugar, and the resulting syrups are boiled in other pans.

Finishing -- The dryer or granulator is usually one or more parallel horizontal, rotating drums 1.5 to 2.4 meters (five to eight feet) in diameter and 7.6 to 11 meters (25 to 35 feet) long which receive steam heated air along with the sugar crystals. The granulators remove most of the one percent moisture still remaining in the sugar after centrifugation and reduce the moisture content to 0.02 percent or less. In addition, the dryers separate the crystals from one another. After drying, the sugar is transferred to coolers -- similar, non-heated drums.

Screening is then used to eliminate all sugar lumps and to size-grade the crystals.

Other Variations -- Four plants, representing seven percent of the industry's total capacity, are liquid sugar refineries. The initial refining steps of affination, decolorization, and evaporation in a liquid sugar refinery are essentially the same as those in a granulated sugar refinery. The primary difference occurs in the fact that liquid sugar refineries do not use vacuum pans to recrystallize their primary product; therefore, such refineries use considerably less condenser water and process steam.

Two plants operate both liquid and crystalline refineries, and eight are directly integrated with cane mills. These latter plants refine the raw sugar directly and in much the same manner as do beet sugar plants; hence, they do not employ the crystallization and remelt steps.

C. Number of Plants and Employment by Segment

The U.S. cane sugar industry employed an estimated 92,140 employees in 1970.

Subsegment	Number of Employees
Farm	64,900
Mill	15,000
Refinery	12,240
Total	92,140

Sugar refineries are characterized as capital intensive rather than labor intensive. In 1968, the total employment in refinery operations was estimated at 13,049, and improved efficiency and productivity (estimated at 1-2 percent per year) reduced 1972 total employment to 12,240. Table I-9 shows the estimated number of employees in each area based on the current productivity of 237 employees per 1,000 tons per day refinery capacity.

Table I- 9. Cane sugar refinery employment by cities in 1970

Location	Number employed
New Orleans	2,280
New York	2,541
San Francisco	1,646
Philadelphia	1,223
Baltimore	797
Boston	982
Savannah	572
Sugar Land	495
Chicago	215
Clewiston	32
Puerto Rico	940
Sub-total	11,723
Other locations	517
Total	12,240

Source: U. S. Cane Sugar Refiners Association, Washington, D. C., by Robert R. Nathan, Assoc., Inc.

II. FINANCIAL PROFILE

A. Plants by Segment

Because the cane sugar industry is subject to considerable government control under the Sugar Act, the Department of Agriculture and the Sugar Division of the Agricultural Stabilization and Conservation Service compile financial data on cane production and milling. Unfortunately, the USDA cost studies exclude the cane sugar refining segment; therefore much of the financial data used in this study was derived from the "Initial Analysis of Economic Impact of Water Pollution Control Costs Upon U.S. Cane Sugar Industry," by ERS of USDA. Other data sources included the U.S. Cane Sugar Refineries Association and a partial economic study which was done for that association by Robert R. Nathan and Associates of Washington, D.C. Finally, the 1972 industry data were checked with a number of industry sources representative of characteristic sugar cane refineries.

Because of this limited financial data, model plants provided the most reasonable basis for developing financial profiles of sugar refineries. Four individual models were constructed to represent (1) a liquid refinery in an urban location, (2) a small crystalline refinery in a rural location, (3) a large crystalline refinery in a rural location, and (4) a large crystalline refinery in an urban location. These models, with their relationship to the cane sugar refining industry, are shown in Table II-1.

1. Annual Profit

Table II-2 shows the sales and earnings for model plants representing one liquid and three sizes of crystalline refineries of different locations. These models, representative of the overall refinery industry, were constructed from a number of sources.

In Table II-3 are actual industry totals submitted to the Cost of Living Council. The $20 million industry-wide profit for 1972 is close to the $25,000,000 industry profit that a weighted total of the five model plants would show. The former figure represents 91 percent of industry and the latter figure is 100 percent.

Table II-4, showing industry returns on sales and investment, indicates the industry is characterized by low returns; indeed, industry profits show a significant decline between 1971 and 1973 (Table II-3) with some companies incurring losses.

Table II-1. Relationship of segment models to industry for cane sugar refinery segments

Type	Location	Model		Industry			
		Size	Capacity (TPD)	No. of plants	Average capacity (TPD)	Total capacity (TPD)	(Pct)
Liquid	Urban	--	500	5	585	2,340	7
Crystalline	Rural	Small	400	8	409	3,680	11
		Large	1,200	4	1,150	4,600	13
	Urban	Large	2,000	12	2,005	24,070	69
Total				29	1,037	34,690	100

Table II-2. Cane sugar refinery models - sales, costs, production and cash flow

		Crystalline			
		Small rural		Large	
	Liquid	PR[1]	Other[2]	rural	Urban
Capacity (TPD)	500	400	400	1,200	2,000
Operating days	250	250	250	250	250
Production - raw value					
Millions hundredweight	2.500	2.000	2.000	6.000	10.000
Production refined[3]					
Millions hundredweight	2.336	1.869	1.869	5.607	9.346
	----------	----------	$1,000	----------	----------
Sales	28,032	22,335	22,335	67,508	118,881
Raw sugar	22,659	16,896	16,896	50,968	85,329
Other costs	4,571	5,430	4,571	14,407	29,550
Interest	194	270	270	564	825
Depreciation	140	168	168	561	1,402
Total costs	27,564	22,764	21,905	66,500	117,106
Net profit before tax	468	(429)	430	1,008	1,775
Net profit after tax	243	(429)	224	524	923
After tax cash proceeds[4]	484	9	533	1,378	2,754

[1] Includes four Puerto Rican refineries based on very incomplete data.

[2] Includes four Mainland small refineries.

[3] Raw value divided by 1.07 for refined value.

[4] Revenue less expenses other than interest, less depreciation and taxes, plus depreciation.

Table II-3. Profit levels of sugar refineries, 1971-1973

Time Period	Number of Companies	Percent of Total Industry Capacity	Net Profit Before Taxes for Period [1]	Change From 71-72	Change From 71-73	Net Profit Before Tax per 100 lbs. Refined Sugar
		%	$	%	%	$
1971	12	91	41,611,437			.313
1972	12	91	20,239,769 [2]	-51.4		.152
1st Quarter '71	12	91	10,194,362			.330
1st Quarter '72	12	91	2,954,662	-71.0		.100
1st Quarter '73	12	91	2,433,078 [3]		-76.1	.080
2nd Quarter '71	11	89	13,974,305			.428
2nd Quarter '72	11	89	8,472,760	-39.0		.258
2nd Quarter '73	11	89	2,469,634 [2]		-82.3	.077

Source: U. S. Cane Sugar Refineries Assn., Washington, D. C. based on survey and data filed with Cost of Living Council, 1973.

[1] Consolidated data for industry.

[2] Includes 3 companies that operated at net loss.

[3] Includes 5 companies that operated at net loss.

Table II-4. Selected financial data for cane sugar refinery models

	Liquid	Crystalline			
		Small rural		Large urban	Urban
		PR	Other		
	$1,000				
Net profit before tax	468	(429)	431	1,008	1,775
Net profit after tax	243	(429)	224	524	923
Cash flow	383	(261)	392	1,085	2,325
Total investment[1/]	6,500	9,500	9,500	18,800	28,500
ROI[2/] before tax	7.2	(4.5)	4.5	5.4	6.2
ROS[3/] before tax	1.7	(1.9)	1.9	1.5	1.5
ROI[2/] after tax	3.7	(4.5)	2.4	2.8	3.2
ROS[3/] after tax	0.9	(1.9)	1.0	0.8	0.8
Cash flow as percent of investment	5.9	(2.7)	2.0	5.8	8.2

1/Estimated book value.

2/Return on investment.

3/Return on sales.

The model plant configurations show losses only for the small rural refineries (essentially, the four Puerto Rican refineries), and other than for these there appears to be no segment which, by virtue of size or location, shows loss. Rather, as will be shown later, the profitability of refineries seems to be a function of management practices.

2. Annual Cash Flows

Estimated annual cash flows (after tax earnings plus depreciation) are displayed in Tables II-2 and II-4. Positive cash flows were obtained for all configurations except the small rural Puerto Rican refineries.

3. Investment Values

Model plant investment values have been derived from industry sources, since there are no current (1972) published data available. An earlier study[1/] reported asset values per hundredweight of sugar produced in 1968; these figures proved unsatisfactory for this study. The following discussion is divided into book values and salvage values.

Estimated Model Book Investment

The data in Table II-5 are projected book values for various model plants based on 1972 figures. Liquid refineries have lower investments than do crystalline refineries because their processes are less complex and they commonly use a higher value raw sugar that contains relatively fewer impurities. Even though most industry plants are 50 years old, modernization has kept their machinery and equipment current. Land values are based on original purchase prices and, therefore, are book values as compared to probably higher replacement values. From these data, it appears, as a rule of thumb, that the depreciable assets or equipment represent approximately one-third of total investment.

Estimated Salvage Values

In determining salvage and investment values all plants were assumed to be independent entities. Since only one company operates five refineries, the independent refinery was considered most characteristic of the industry. Under multi-plant operations, however, working capital is combined for the company rather than operated for individual mills and might show a somewhat different arrangement for salvage value than has been indicated here. The salvage values in Table II-5 assumed that net working capital is a current asset, and, therefore, fully recoverable. Depreciable assets, buildings and equipment, are shown to be recoverable at approximately 10 percent of the book value. For land, it is felt that book values represent conservatively judged market values.

1/ "Initial Analysis of the Economic Impact of Water Pollution Control Costs Upon the U.S. Cane Sugar Industry." USDA - ERS, Bruce J. Walter and Peter M. Emerson.

Table II-5. Cane sugar refineries investment[1/] and salvage values

	Liquid			Small Rural			Large Rural			Large Urban		
	Invest-ment	%	Salvage	Invest-ment	%	Salvage	Invest-ment	%	Salvage	Invest-ment	%	Salvage
	millions of dollars											
Working capital	2.50	100	2.50	3.50	100	3.50	8.00	100	8.00	12.00	100	12.00
Depreciable assets	3.50	10	.35	5.50	10	.55	10.00	10	1.00	15.00	10	1.50
Land	.50	100	.50	.50	100	.50	.80	100	.80	1.50	100	1.50
Total investment	6.50			9.50			18.80			28.50		
Total salvage			3.35			4.55			9.80	9		15.00

[1/] Estimated book value.

4. Cost Structure

The basic cost structure for the study's five model plants is shown in Table II-6. "Returns" also shown in Table II-5 are similar to the 1972 published averaged wholesale prices of refined sugar at various markets:

Northeast	$13.09
Chicago and West	12.00
Gulf	12.14
Southeast	12.74
Pacific	11.65
Average U.S.	12.29

While average sale prices to the distributor reflect these wholesale prices, they vary from them because of discounts and various trade allowances. The Northeast market traditionally carries the highest wholesale price; thus, the urban refineries generally so located, show the highest returns.

Table II-5's raw sugar price reflects New York spot prices, prices which depend upon refinery location and the source of the raw cane. The 1972 quoted raw sugar prices (New York delivery) are shown below:

Raw Cane Spot-Price-World	$8.53
Raw Cane Spot-Price-Domestic	9.09

The liquid sugar plants traditionally buy a sugar of fewer impurities (high polarity domestic sugar) than do the crystalline sugar refineries. Since the liquid refineries normally pay a premium for their raw sugar, Table II-5 shows the highest raw sugar price at $9.70 per hundredweight for three plants.

All other refinery costs vary from a low of $2.04 for the liquid plants to a high of $3.25 for the urban plants. The urban plant costs reflect the higher labor and other costs of the urban area; the liquid model plant's costs indicate its less costly processing and lower investment. The small, rural crystalline refineries have higher costs than do the other rural plants, due largely to Puerto Rico's higher costs.

Depreciation costs vary from $.06 per hundredweight for the liquid refineries to $.15 for the urban refineries (4.28 percent to 10.0 percent on a net asset value basis).

The model plants' estimated income taxes were based upon a straight 48 percent tax rate on earnings. No carry forward or back provisions were assumed in the case of losses.

Table II-6. Refinery cost by model size - 1972

		Crystalline			
		Small rural			
	Liquid	PR[1/]	Other[2/]	Large rural	Large urban
	Per hundred weight refined sugar				
Returns	$12.00	$11.95	$11.95	$12.04	$12.72
Raw sugar	9.70	9.04	9.04	9.09	9.13
Other costs	2.04	3.05	2.59	2.67	3.25
Depreciation	.06	.09	.09	.10	.15
Total costs	11.80	12.18	11.72	11.86	12.53
Net profit	.20	-(.23)	.23	.18	.19

[1/] Includes four Puerto Rican refineries.

[2/] Includes four domestic mainland refineries.

The cost summary indicates that raw materials constitute the major cost and that equipment and investment are significant. The industry is capital intensive.

5. Cost of Capital

An estimated cost of capital for the cane sugar refining industry was derived from an analysis of the financial reports of four publicly held companies. Three factors were estimated: (1) common equity to total capital, (2) long-term debt to total capital, and (3) a five-year average for dividend yield on common stock.

The estimated averages were as follows:

Common equity/total capital	.66
Long-term debt/total capital	.34
Dividend yield (5-year average)	.046

Other assumptions were: (1) long-term interest rates averaged 6.4 percent, (2) the corporate tax rate was 22 percent on the first $25,000 and 48 percent on income above $25,000, (3) the growth rate in dividends was at least equal to the annual rate of inflation, which for this analysis is estimated at 4 percent.

The cost of equity capital was then estimated as follows:

$$k = \frac{D}{P} + g$$

where: k = cost of capital

D = dividend

P = stock price

g = growth rate

The average cost of capital was calculated to reflect the relative weights of equity and debt:

Capital	Weight	Cost	Growth	Wtd. Cost
Equity	.66	.046	.04	.057
Debt (6.4 X 52%)	.34	.033	--	.011
Av. cost				.068

B. Relationship of Financial Data to Plant Size and Location

Quite clearly, then, both model plant and industry data indicate that little causal relationship exists between a plant's size or location and its returns and profits.

C. Ability to Finance New Investment

The ability of a firm to finance new investment for pollution abatement is a function of several critical financial and economic factors. In general terms, new capital must come from one or more of the following sources: (1) funds borrowed from outside sources; (2) equity capital through the sale of common or preferred stock; (3) internally generated funds -- retained earnings and the stream of funds attributed to depreciation of fixed assets.

For each of the three major sources of new investment, the most critical set of factors is the financial condition of the individual firm. For debt financing, the firm's credit rating, earnings record over a period of years, stability of earnings, existing debt-equity ratio and the lenders' confidence in management will be major considerations. New equity funds through the sale of securities will depend upon the firm's future earnings as anticipated by investors, which in turn will reflect past earnings records. The firm's record, compared to others in its own industry and to firms in other similar industries, will be a major determinant of the ease with which new equity capital can be acquired. In the comparisons, the investor will probably look at the trend of earnings for the past five or so years.

Internally generated funds depend upon the margin of profitability and the cash flow from operations. Also, in publicly held corporations, stockholders must be willing to forego dividends in order to make earnings available for reinvestment.

The condition of the firm's industry and the general economy are also major considerations in attracting new capital. The industry will be compared to other similar industries (i.e., other processing industries) in terms of net profits on sales and on net worth, supply-demand relationships, trends in production and consumption, the state of technology, impact of government regulation, foreign trade and other significant variables. Declining or depressed industries are not good prospects for attracting new capital. At the same time, the overall condition of the domestic and international economy can influence capital markets. A firm is more likely to attract new capital during a boom period than during a recession. On the other hand, the cost of new capital will usually be higher during an expansionary period. Furthermore, the money markets play a determining role in new financing; example, the 1973 year has been viewed as especially difficult in new equity issues.

As was seen in Table II-3, no significant difference in returns for cane sugar refineries results from plant size or location. Except for those of the government controlled Puerto Rican refineries which do not compete in the open market, all earnings records depend on management practice.

Only limited financial data are available for companies which operate cane sugar refineries. Table II-7 presents selected data on four companies, three of which are primarily sugar companies. (The fourth, Southdown, a producer of both raw and refined sugar, is a widely diversified company whose operating data are not representative of the industry; consequently, its data are not considered in the following analysis.)

Recent profit margins (income before interest and federal income taxes as a percent of sales) have averaged 7.0 percent for Savannah, 6.9 percent for Amstar and 3.4 percent for Sucrest. Net income as a percent of sales has averaged 2.5 for Savannah, 2.3 for Amstar and 0.9 for Sucrest.

Estimated income as a percent of net worth for Savannah is 13.1 (two years, 1970-71); for Amstar, 8.5 (5-year average, 1968-72); and for Sucrest, 5.7 (5-year average, 1968-72).

Depreciation has averaged three to four percent of gross property values for these three companies and has resulted in an average cash flow as a percent of sales of 4.1 percent for Amstar and Savannah and 1.9 percent for Sucrest.

These companies appear sufficiently profitable to finance new investment. Sucrest, with a low profit margin and earnings of approximately one percent on sales and five to six percent on equity, has nevertheless laid out from $1.4 to $3.1 million annually for capital expenditures from 1968 through 1972.

The long-term debt situation shows that the three companies have from 20 to 30 percent of gross property in fixed debt. Savannah has a 1972 debt-equity ratio of 98.3 percent compared to 44.7 percent for Amstar and Sucrest. Although Sucrest is highly leveraged, the three companies show no indication that borrowing for pollution abatement capital expenditures would be prohibitive.

With respect to the industry's overall ability to fund new investment for pollution control, the limited data available indicate that while larger companies should have no difficulty financing pollution controls, some cane sugar refineries may encounter difficulty. While other factors may influence the decision concerning new investment in these small refineries, the low return on investment suggests strongly that these resources could be more profitably employed elsewhere.

Table II-7. Financial ratios for selected cane sugar refining companies, 1968-1972

Year	Amstar	Savannah Foods	Southdown	Sucrest
		Profit Margin (%)		
1968	6.6	N.A.	6.4	3.2
1969	5.9	N.A.	19.2	3.0
1970	7.3	7.3	12.6	3.7
1971	8.0	6.7	13.7	4.1
1972	6.5	N.A.	15.2	3.1
Av.	6.9	7.0	13.4	3.4
		Net Income to Sales (%)		
1968	2.1	N.A.	22.2	1.0
1969	1.6	N.A.	24.6	0.8
1970	2.5	2.9	8.7	1.0
1971	3.1	2.5	9.1	1.1
1972	2.4	2.0 1/	10.6	0.6
Av.	2.3	2.5	15.0	0.9
		Depreciation to Gross Property (%)		
1968	3.3	N.A.	3.4	4.1
1969	1.7	N.A.	0.6	4.3
1970	3.5	3.4	3.9	4.3
1971	3.4	3.5	4.3	4.2
1972	3.4	N.A.	3.5	4.2
Av.	3.1	3.5	3.1	4.2
		Cash Flow to Sales (%)		
1968	3.9	N.A.	18.0	2.1
1969	3.6	N.A.	19.1	1.9
1970	4.3	4.2	8.5	2.0
1971	4.6	3.9	9.4	2.1
1972	4.0	N.A.	9.9	1.6
Av.	4.1	4.1	13.0	1.9
		Net Income to Net Worth (%)		
1968	7.4 2/	13.6 2/	14.8 2/	4.8 2/
1969	7.0 2/	14.1 2/	N.A.	4.6 2/
1970	9.3 2/	13.8 2/	N.A.	6.6 2/
1971	13.6	12.2	N.A.	7.7
1972	9.7	N.A.	N.A.	4.6
Av.	9.4	13.4	14.8	5.7
		Long-term Debt to Gross Property (%)		
1968	28.0	N.A.	N.A.	41.5
1969	27.2	N.A.	26.7	36.9
1970	25.3	31.4	50.2	33.7
1971	22.8	28.9	54.9	31.0
1972	21.0	N.A.	60.3	27.8
Av.	24.9	49.0	48.0	34.2

1/ 9 months

2/ From Report of the Federal Trade Commission on Rates of Returns in Selected Manufacturing Industries, Federal Trade Commission, 1961-1970, p. 35.

Source: Standard and Poor's Stock Market Reports.

It should be noted that the foregoing financial analyses have not included the Puerto Rican refineries. The picture is complicated by the fact that the Commonwealth of Puerto Rico owns or leases the company's properties.

III. PRICING

Cane sugar refineries are but one segment of the sugar industry, an industry which is, itself, but one segment of the sweetener sector of the U.S. food system. Too, cane sugar, though it accounts for the larger share of the market (Figure III-1), directly competes with beet sugar.

Through a quota system which regulates the production and importation of sugar, the government stabilizes and maintains prices at specified levels. Refined sugar is marketed by refiners and processors under a system of base point pricing. The structure of the sugar industry and government policy provide possible limitations on the sugar processors' ability to shift the cost of additional pollution abatement to the consumers in the long run.

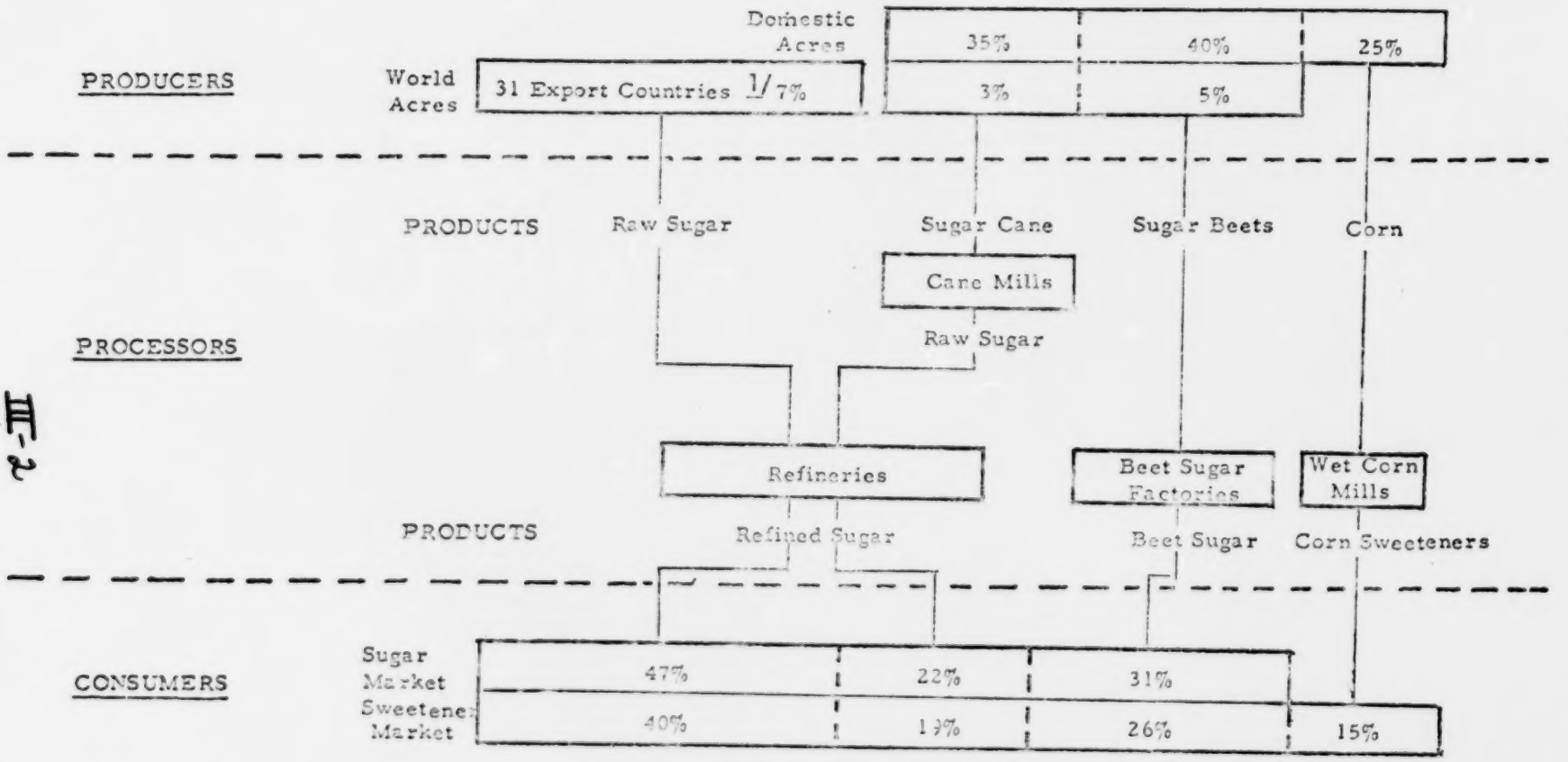
A. Price Determination

1. Demand

Nearly all domestic sugar is consumed as human food. The U.S. per capita sugar consumption (Table III-1) had been fairly stable since the 1930's at between 90 and 100 pounds, but recent increases, attributed to the Food and Drug Administration restrictions on the use of cyclamates has placed it above 100. (Sugar and corn sweeteners (corn syrup and dextrose) are classified as nutritive sweeteners; cyclamates and saccharine are classified as noncaloric sweeteners.) About two-thirds of all sugar is consumed in industrial use, especially by food processing industries. Only one-fourth is purchased for kitchen and table use, and the remainder is used in restaurant and institutional meal preparation.

Food processors are the major consumers of industrial sugar (Table III-2). The beverage industry is the heaviest user of both sugar and noncaloric sweeteners (it uses relatively little corn syrup sweetening).

The second major industrial user of sugar, the baking industry, has experienced a decline in its use from 80 percent of total nutritive sweeteners in 1956 to less than 74 percent in 1972. Sugar's share of the confectionary industry's demand for nutritive sweeteners has been more stable, declining from 70 percent in 1956 to 68 percent in 1972. Although sugar's share of the canning industry's demand has fallen from 87 percent in 1956 to 82 percent in 1972, its share has generally been increasing since 1967. From 1956 to 1972 the price of corn sweeteners (the chief nutritive sweetener substitute for sugar) has fallen relative to sugar, and new production techniques have improved its quality.



1/ Estimated percentage of total world acres used to produce U.S. raw sugar imports.

Figure III-1. Structure of the domestic sweetener industry.

Table III-1. Trends in per capita distribution of nutritive sweeteners and the share that each sweetener represents of the total distribution, 1956-71

Calendar year	Nutritive sweeteners	Sugar	Corn sirup	Dextrose	Percent of total nutritive sweeteners		
					Sugar	Corn sirup	Dextrose
	Pounds per capita refined				Percent		
1956	110.8	98.7	8.3	3.7	89.1	7.5	3.4
1957	106.4	94.6	8.2	3.6	88.9	7.7	3.4
1958	109.8	96.9	8.7	4.1	88.3	8.0	3.7
1959	109.9	96.4	9.1	4.3	87.7	8.2	3.9
1960	110.9	97.5	9.3	4.1	87.9	8.4	3.7
1961	111.6	97.7	9.7	4.2	87.5	8.7	3.8
1962	113.1	98.0	10.7	4.4	86.6	9.5	3.9
1963	113.7	97.6	11.1	5.0	85.8	9.8	4.4
1964	113.3	96.2	12.2	4.9	84.9	10.8	4.3
1965	113.6	96.6	12.2	4.8	84.9	10.8	4.3
1966	115.3	98.1	12.5	4.7	85.1	10.9	4.0
1967	114.5	97.2	12.6	4.6	84.9	11.0	4.1
1968	117.7	100.2	12.8	4.7	85.1	10.9	4.0
1969	118.1	100.3	13.0	4.8	84.9	11.0	4.1
1970	121.0	102.5	13.1	5.4	84.7	10.8	4.5
1971	122.3	102.9	13.7	5.7	84.1	11.2	4.7
1956-67 trend	+.61	+.04	+.46	+.11	-.44	+.37	+.08
1968-71 trend	+1.67	+1.03	+.28	+.36	-.32	+.07	+.25
1956-71 trend	+.84	+.34	+.39	+.11	-.34	+.28	+.06

Source: USDA, ASCS, Sugar Reports.

Table III-2. Sugar deliveries, by type of sugar and by type of product or business of buyer, calendar year 1971. 1/

Product or business of buyer	Beet	Cane	Imported direct consumption	Total all sugar	Liquid sugar included in totals: Beet	Liquid sugar included in totals: Cane
	Hundredweights 2/					
Industrial						
Bakery, cereal and allied products	9,847,388	17,115,774	161,348	27,124,510	292,403	2,377,746
Confectionery and related products	6,653,051	14,236,521	156,920	21,046,492	167,552	3,269,348
Ice cream and dairy products	4,074,342	7,001,147	49,445	11,124,934	2,150,928	4,783,993
Beverages	11,926,601	35,310,248	50,103	47,286,952	5,831,266	22,768,934
Canned, bottled, frozen foods, jams, jellies and preserves	9,458,478	11,004,504	111,587	20,574,569	3,564,693	5,325,399
Multiple and all other food uses	4,003,454	5,855,962	58,025	9,917,441	269,138	1,585,445
Non-food products	282,605	1,537,700	40,276	1,860,581	54,002	381,339
Sub-total	46,245,919	92,061,856	627,704	138,935,479	12,329,982	40,692,204
Non-industrial						
Hotels, restaurants, institutions	98,373	1,455,605	33,566	1,587,546	12,868	100,862
Wholesale grocers, jobbers, sugar dealers	12,522,604	30,132,194	542,662	43,197,460	345,371	311,983
Retail grocers, chain stores, super markets	4,799,114	21,031,042	750,103	26,580,319	116,833	227,642
All other deliveries, including deliveries to Government agencies	591,438	1,300,258	2,588	1,903,284	100,841	81,350
Sub-total	18,011,531	53,928,099	1,328,979	73,268,609	575,913	721,837
Total deliveries	64,257,450	145,989,955	1,956,683	212,204,088	12,905,895	41,414,041
Included in totals:						
Deliveries in consumer-size packages (less than 50 lbs)	9,591,717	41,954,005	652,985	52,198,707		
Deliveries in bulk (unpackaged)	25,318,587	34,622,624	144,527	60,085,738		

1/ Represents approximately 100.0 percent of deliveries by primary distributors in continental United States.
2/ Reported as produced or imported and delivered except liquid sugar which is on a sugar solids content basis.

Source: USDA-ASCS, Sugar Reports, No. 238 (March, 1972), p. 14.

Clearly, product substitution exists among sweeteners. Noncaloric sweeteners meet the demands of those consumers seeking to limit sugar intake. Though some substitution of noncaloric sweeteners for sugar apparently reflects relative price changes, the demand for noncaloric sweeteners is dependent essentially on quality considerations. Corn sweeteners are sugar's major price competitor. Technical improvements in the manufacture of corn syrup (sugar's chief price competitor) have produced a range of syrups of different qualities and improved corn syrup's ability to meet the different specifications of users. A limiting factor is corn syrups' lower sweetness; however, research devoted to improving "corn syrup's sweetness" is promising.

Japan's recent development processes for the production of high levulose and high fructose corn syrups show great promise and may have a significant impact on the future U.S. sweetener market. These syrups, produced by partial isomerisation of dextrose (corn sugar) into levulose, are said to be comparable to sucrose (cane and beet sugar) in sweetening power and, unlike other corn syrups, can be used as complete substitutes for sucrose. Such improvements and lower relative prices have made corn syrup a stronger competitor of sugar.

The substitution of corn syrup will be gradual, will require the impetus of long-run changes in prices, and will be difficult. Substitution of corn syrups will require investments for different manufacturing techniques, may change the quality of the final promotional programs to alter the consumer preferences. Such difficulties mean that the food processor will shift from one source to another slowly and only when the processor can justify the change over time. Too, in some instances, the degree to which corn syrup may be used is restricted by the Food and Drug Administration. In other cases, corn syrup may be an unacceptable substitute.

The price war which began in December, 1971, among the corn syrup producers dropped the equivalent cost ratio of corn syrup to sugar from 70 percent to 36 percent, and the eventual rise in corn syrup prices (to 7.25 cents per pound in New York in April, 1973) left prices at only 55 percent of equivalent sugar price in the Northeast (Table III-3).

As would be expected from the foregoing, then, production of corn syrup is up and facilities are fully utilized. Amstar, the cane sugar producer of "Domino" cane sugar and an owner of Spreckels' beet sugar division has recently begun producing corn syrup.

Table III-3. Wholesale prices of sugar, corn syrup, and dextrose

Year	Refined sugar Northeast	Dextrose N.Y.	Corn Syrup N.Y.	Dextrose relative to sugar	Corn syrup relative to sugar
	cents per pound, dry basis				
1956	8.77	7.91	8.90	90	101
1957	9.15	8.32	9.17	91	100
1958	9.27	8.33	9.18	90	99
1959	9.33	8.13	9.10	87	98
1960	9.43	8.13	9.12	86	97
1961	9.40	8.10	9.00	86	96
1962	9.60	8.04	8.73	84	91
1963	11.94	9.10	9.19	76	77
1964	10.68	8.85	8.36	83	78
1965	10.22	8.70	8.27	85	81
1966	10.36	8.87	8.34	86	81
1967	10.62	9.49	8.40	86	79
1968	10.84	9.49	7.85	86	72
1969	11.44	9.96	8.01	85	68
1970	11.97	10.20	8.45	85	
1971	12.48	10.71	8.77	86	70
1972	13.09	10.07	5.73	77	44
1973	14.07	10.79	8.53	77	60

Source: Sugar Reports, USDA-ASCS, selected issues.

Demand and Price Elasticity

Estimates of price elasticity and cross elasticity of demand for the industrial use of sugar do not exist. Price consciousness appears to increase as the cost of sugar increases in proportion to total food costs; thus, substitution seems to be occurring. The gradual adjustments indicate that demand is much more price elastic in the long run.

Household use accounts for about one quarter of sugar's total consumption. Because sugar is a minor item in the household budget, little substitution is felt in response to price changes. Estimates of price elasticity of demand for household use of sugar confirm this inelasticity with estimates ranging from -0.6 to -.24.[1/] Income too, has little influence, and income elasticities estimates range from .03 to 0.15[1/]. The corn syrup price cross elastic is also minor at 0.05[1/]. Households, then, will make little change in sugar consumption in response to changes in prices or incomes.

2. Government Sugar Policy[2/]

The U.S. sugar industry has been protected and regulated by the federal government since 1789. A quota system of control was initiated in 1934, and has been periodically amended and extended. The current legislation governing the industry is the Sugar Act of 1948. It was amended in 1971, became effective on January 1, 1972, and extended the Act through December 31, 1974.

The principal provisions of the U.S. Sugar Act of 1948 are (1) limitation on the total supply of sugar available to U.S. consumers, (2) government subsidy payments to U.S. sugar cane and sugar beet growers, (3) an excise tax on all sugar marketed within the U.S., and (4) a tariff on sugar imports.

1/ Thomas H. Bates and Andrew Schmitz, "A Spatial Equilibrium Analysis of the World Sugar Economy," Giannini Foundation Monograph No. 24, University of California, Berkeley, 1969, and P.S. George and G.A. King, "Consumer Demand for Food Commodities in the U.S. with Projections for 1980," Giannini Foundation Monograph No. 26, University of California, Berkeley, 1971.

2/ Adapted from "Initial Analysis of the Economic Impact of Water Pollution Control Costs Upon the U.S. Cane Sugar Industry," Bruce J. Walter, and Peter M. Emerson, ERS, USDA (1973).

Under the supply limitation provision of the Sugar Act, the Secretary of Agriculture each year (a) will, in order to attain specified price objectives, determine the quantity of sugar needed to meet the requirements of domestic consumers, (b) will divide, by means of quotas, this total supply requirement among specified domestic and foreign production areas, (c) will assign, when necessary for orderly production, "proportionate shares" of each domestic production area quota to individual farms within that production area, and (d) will impose, when necessary for orderly marketing, a refined sugar "marketing allotment" upon each refining and importing firm. (See Table III-4 for the 1970, 1971 and 1972 quotas assigned to each domestic production area and foreign country.) Through these strong supply limitation powers granted by the Sugar Act, the Secretary of Agriculture is able to control the price of raw sugar.

The price objective specified in the Sugar Act is intended to maintain the same ratio between (a) the price of raw sugar, as registered in the New York market, and (b) the average of (i) the parity index (the index of prices paid by all farmers for commodities and services, including interest, taxes, and farm wages, 1967 = 100) and (ii) the wholesale price index (1967 = 100) that existed during the period September 1, 1970, through August 31, 1971. The Secretary of Agriculture is required to make appropriate adjustments in his determination of national consumption requirements whenever the average price of raw sugar varies from the objective by 4 percent or more for 7 consecutive days (3 percent or more during November, December, January and February).

Sugar marketing is controlled under the provisions of the U.S. Sugar Act and numerous changes in the law since 1934 have permitted significant increases in the output of domestically produced raw sugar. Even larger increases have been granted to domestic refiners. Over time, the increases granted to each of the domestic sugar cane producing areas have been markedly different. Although this has had little effect on sugar refineries, it has limited both the size of and degree of modernization of sugar milling plants.

The Sugar Act provides for subsidy payments to U.S. sugar cane and sugar beet growers. These payments are made only to growers who meet the following conditions:

a. that the grower has not marketed cane or beets in excess of the proportionate share for the farm, as determined by the Secretary of Agriculture,

b. that no child labor (except family members) has been employed on the farm,

c. that all employed labor has been paid in full at not less than the minimum wage determined by Secretary, and

d. that growers who are also processors have paid other growers for purchased cane or beets at prices not less than those set by the Secretary.

Table III-4. U.S. Sugar quotas: 1970, 1971 and 1972 basic and adjusted quotas by domestic production area and foreign country

Production area	1970		1971		1972	
	Basic Quota	Adjusted Quota 1/	Basic Quota	Adjusted Quota 1/	Basic Quota	Adjusted Quota 1/
	(short tons, raw value)		(short tons, raw value)		(short tons, raw value)	
Domestic						
Domestic beet	3,597,000	3,597,000	3,454,000	3,406,333	3,692,000	3,400,000
Mainland cane	1,308,000	1,308,000	1,256,000	1,256,000	1,643,000	1,643,000
Hawaii	1,145,486	1,145,486	1,110,000	1,110,000	1,218,238	1,218,238
Puerto Rico	1,140,000	360,000	1,140,000	150,000	855,000	175,000
Virgin Islands	15,000	--	15,000	--	--	--
Total domestic	7,205,486	6,410,486	6,975,000	5,922,333	7,408,238	6,436,238
Foreign						
Total Foreign	4,394,514	5,189,514	4,325,000	5,377,667	4,391,762	5,363,762
Grand Total	11,600,000	11,600,000	11,300,000	11,300,000	11,800,000	11,800,000

1/ Adjustments reflect (a) changes in total U.S. sugar requirements, (b) withheld quotas, and (c) deficits and deficit prorations.

Source: USDA-ASCS, Sugar Reports, No. 243 (August 1972), pp. 22-24.

Subsidy payments provide a powerful financial incentive for growers to observe the conditions imposed by the Sugar Act. If a grower fails to meet these conditions--i.e., if he attempts to market beets or cane in excess of his assigned 'proportionate share'--his payments are reduced or withheld entirely. Thus, subsidy payments are the principal legal device for obtaining compliance by domestic growers, just as import licenses are the means for obtaining compliance for foreign suppliers.

Conditional payments are made at the basic rate of 80 cents per 100 pounds of sugar recoverable from the cane or beets grown on farms producing less than 350 tons of sugar, raw value. The rate declines by stages to 30 cents per 100 pounds for all sugar in excess of 30,000 tons produced on a farm. In addition, growers may receive payments for abandoned acreage at the rate of one-third the normal yield for the farm. Payments may also be received for crop deficiencies caused by drought, flood, storm, freezing, disease, or insects which result in yields below 80 percent of normal. Generally, the payments for abandonment and deficiency are much smaller than the conditional payments made for sugar cane and sugar beets which are harvested and marketed. The 1970 and 1946-69 average return to sugar cane growers, including government payments, are presented in Table III-5 by production area and revenue source.

An excise tax is levied on sugar at the rate of 50 cents per 100 pounds, raw value. This tax is collected on all sugar marketed in the United States regardless of source. Receipts from the tax in recent years have averaged more than $100 million per year, but payments to sugar cane and sugar beet growers have averaged about 15 percent less than the tax. Thus, the U.S. sugar program generates revenue which is deposited in the general funds of the U.S. treasury. However, it should be noted that the subsidy payments made under the Sugar Act and the sugar excise tax are legally separate. Either one could be amended or repealed without affecting the other.

The equitable distribution of the benefits which the Sugar Act created was provided in addition to controlling the supply of sugar, imposing a tax on sugar sales, and subsidizing sugar cane and sugar beet growers. For example, most small-scale sugar cane growers have no investment in the mill to which they sell their cane and usually have little freedom in selecting a mill. In most cases, only one or two mills are located near enough to a given farm to permit the economical transportation of cane. In order to protect such growers, the USDA annually determines a minimum price for sugar cane grown in each of the four domestic production areas. This price is established by a formula related to the quality of the sugar cane and the market price of raw sugar for a specified period. For most independent growers in most years, this minimum price is the actual price received. The independent grower's ability to influence the price of sugar cane largely depends, therefore, upon the arguments and evidence which he can show to the Sugar Act administrators who set the minimum prices.

Table III-5. Sugarcane growers' returns by production area and source, 1970 and 1946-69 average.

Production Area	Basis of Payment 1/		Processor Payments			Sugar Act Payments			Total Payments	
	Raw sugar (per pound)	Molasses (per gallon)	Per ton of sugarcane produced for sugar: Sugar	Molasses	Total 2/	Per ton of sugarcane produced for sugar: Sugar	Abandonment and deficiency	Total	Per ton of sugarcane produced for sugar	Total
	Cents	Cents	Dollars per ton		1,000 Dollars	Dollars per ton		1,000 Dollars	Dollars per ton	1,000 Dollars
Louisiana										
1946-69 avg.	6.50	14.73	7.13	.29	43,813	1.24	.03	7,319	8.68	51,133
1970	8.19	13.08	9.09	.24	64,629	1.25	.01	8,692	10.59	73,321
Florida										
1946-69 avg.	6.45	14.98	7.86	.28	23,473	.89	.02	2,540	9.05	26,001
1970	8.37	14.15	11.67	.27	67,712	1.08	3/	6,121	13.02	73,833
Hawaii										
1946-69 avg.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1970										
Puerto Rico										
1946-69 avg.	5.93	11.26	7.92	.35	78,434	1.44	.02	4/15,045	9.73	93,898
1970	7.32	11.63	7.18	.59	45,773	1.08	0	6,341	8.85	52,114

1/ Seasons' average prices based on selected periods of varying length.
2/ Seasons' average prices including molasses payment paid by processors to growers multiplied by sugarcane production.
3/ Less than 0.5 cents.
4/ Includes Commodity Credit Corporation payments for 1945-46.

Source: The Gilmore Louisiana-Florida-Hawaii Sugar Manual, 1971.
USDA-ASCS, Sugar Reports, various issues.

Imported sugar is sold at the same level of prices paid for domestically produced sugar. Sugar prices in the United States generally have been much higher than those prevailing in the world market (Table III-6). During the past two decades, world prices have exceeded the U.S. price only in 1950-51[1/], 1963-64, and 1972[1/]. High U.S. sugar prices make this country a very desirable market for sugar exporting nations, especially those which do not have other preferred markets such as the United Kingdom or France. The value of the U.S. sugar market to an exporting nation is also affected by the importance of sugar exports to that nation's economy and the share of its sugar exports which can be sold in the United States.

In addition to being the dominant factor in determining domestic sugar prices, the U.S. sugar program is, at times, also an important factor influencing world sugar prices. Each time that world sugar prices have risen sharply, U.S. prices have also risen (though more moderately), for when world prices have so increased, the Secretary of Agriculture has increased the U.S. sugar consumption requirement so as to make more sugar available to consumers here. In 1950, the increase was from 7.5 million to 8.7 million tons; in 1957, from 8.8 million to 9.3 million tons; in 1963, from 9.8 million to 10.4 million tons; and in 1972 from 11.2 million to 11.8 million tons. In each case, the increased supply of sugar for U.S. consumers moderated the price rise here but, by decreasing supplies available for other importing countries, caused world prices to rise even further than expected. Since the United States is by far the world's largest importer of sugar--taking 20 to 25 percent of the total in world trade--unexpected changes in the volume of this country's imports have an appreciable effect on all other sugar importing and exporting countries.

Although U.S. sugar prices since the end of World War II have usually been maintained above the world market level, it does not follow that U.S. prices would have declined to the world level if quotas had not existed and import duties were unchanged. Without quotas, U.S. prices would have declined and those in the world market would have risen until they balanced at some intermediate level. No estimates of changes in U.S. and world prices, based on various assumptions regarding changes in quotas and tax policies, are available.

In addition to obviously benefiting foreign exporters who share in the U.S. market quotas, the U.S. sugar program has both benefited the domestic sugar industry and increased the average price paid by sugar users. The disadvantage to consumers of higher sugar prices has been partially offset by the benefit of the generally extreme price stability of sugar relative to that of other agricultural products.

[1/] Exceeded U.S. prices in some months but not for year average.

Table III-6. Raw sugar prices in New York and the world market, 1948-72

Year	Raw sugar in New York	World sugar 1/	Difference: New York over world
	cents per pound		
1948	5.54	5.13	0.41
1949	5.81	5.03	0.78
1950	5.93	5.82	0.11
1951	6.06	6.66	-0.60
1952	6.26	5.08	1.18
1953	6.29	4.27	2.02
1954	6.09	4.14	1.95
1955	5.95	4.19	1.76
1956	6.09	4.47	1.62
1957	6.24	6.10	0.14
1958	6.27	4.36	1.19
1959	6.24	3.86	2.38
1960	6.30	4.09	2.21
1961	6.30	3.85	2.45
1962	6.45	3.87	2.58
1963	8.18	9.41	-1.21
1964	6.90	6.79	0.11
1965	6.75	3.07	3.68
1966	6.99	2.81	4.18
1967	7.28	2.95	4.33
1968	7.52	2.96	4.56
1969	7.75	4.37	3.38
1970	8.07	4.88	3.19
1971	8.52	5.65	2.87
1972	9.09	8.53	0.56
1973	10.29	9.61	0.68

1/ Adjusted to the New York delivery base.

Source: USDA-ASCS, Sugar Reports.

The requirement that the Secretary of Agriculture adjust quotas for domestic areas is relative to this study's concern with the economic impact of effluent controls. For example, should effluent control costs close mills and reduce cane production, the Secretary of Agriculture is required by law to distribute the lost production to other domestic quota areas first and then to import quotas. The Secretary is directed to set quotas for the coming year such that the price objective for raw sugar as defined in the law is satisfied. If abandoned cane production were not reallocated, the resulting shortage of sugar would increase wholesale prices and cause refiners to bid up the price of raw sugar to levels above the price objective.

3. Base Point Pricing

Base point pricing developed because large refineries found it economical to locate close to ports of entry or adjacent to major population centers, and as these refineries became the major sellers in their respective areas, they established base point pricing. Eight points of origin are used in this base point pricing.

Within any given region, the price at any point is the origin sugar price plus the freight cost from base point to the buyer's location. The principal seller in a region sets the price so as to maximize his profit in the region.

Chicago, because it is both a major rail transporation and food processing industry center, has become the most intensely competitive market, and one in which all sugar producers attempt to market their excess sugar. Such conditions and the dynamics of base point pricing have made Chicago prices the nation's lowest (Table III-7).

4. Supplies

Imports play a major role in supplying U.S. sugar needs. Forty-five percent of the total supply is imported, 26 percent comes from domestic sugar cane, and 29 percent from domestic sugar beets.

B. Expected Price Impacts

The refining industry will find it difficult to pass through the costs of effluent control investments. Although household sugar demand is relatively inelastic, and price increases would not alter the consumption patterns significantly, industrial users, because of the availability of substitute sweeteners appear to be price conscious. This condition and the price stability imposed by direct government price controls make it doubtful that significant price increases can be achieved in the long run.

Table III-7. Wholesale prices for refined sugar, March 1973.

Location	100 lb. bag.	bulk
	cents per lb.	
Northeast	13.31	12.70
Midcentral	12.85	12.25
Western Ohio-Lower Michigan	12.20	12.05
Southeast	12.95	12.45
Gulf	12.40	12.05
Chicago - West	11.75	11.55
Intermountain North	12.05	11.80
Pacific Coast	11.85	11.70

Source: Sugar Reports, USDA-ASCS (April, 1973).

Pricing will also be affected by the response of the beet sugar industry to pollution controls. However, it should be noted that in an analysis of the impacts of those controls on the beet sugar industry1/ it was concluded that the imposition of water pollution controls would not significantly increase prices due to the large amount of in-place control currently being achieved.

Ultimately, the ability of the industry to pass along cost increases will depend on government sugar policy. Supply curtailment in the cane mill segment could mean price increases to refiners and consumers if quotas were not adjusted accordingly and if world sugar prices remained at present levels. (Imports constitute 45 percent of the U.S. supplies.) Too, as has been discussed, any significant curtailment of U.S. domestic cane production could mean that the exceptionally strong world sugar prices will continue. Apparently, much of the projected price effect will depend on the impact of pollution controls on the cane mill production.

1/ Economic Analysis of Effluent Guidelines: Beef Sugar Industry, Environmental Protection Agency, EPA-230/2-75-002, August, 1975.

IV. ECONOMIC IMPACT ANALYSIS METHODOLOGY

The following economic impact analysis utilizes the basic industry information developed in Chapters I-III plus the pollution abatement technology and costs provided by Environmental Protection Agency. The impacts examined include:

Price effects
Financial effects
Production effects
Employment effects
Community effects
Other effects

Due to the causal effect of potential plant shutdowns (financial and production effects) on the other impacts, a consequent emphasis will be devoted to the financial and plant closure analysis.

In general, the approach taken in the impact analysis is the same as that normally done for any feasibility capital budgeting study of new investments. In the simplest of terms, it is the problem of deciding whether a commitment of time or money to a project is worthwhile in terms of the expected benefits derived. This decision process is complicated by the fact that benefits will accrue over a period of time and that in practice the analyst is not sufficiently clairvoyant nor physically able to reflect all of the required information, which by definition must deal with projections of the future, in the cost and benefit analysis. In the face of imperfect and incomplete information and time constraints, the industry segments were reduced to money relationships insofar as possible and the key non-quantifiable factors were incorporated into the analytical thought process to modify the quantified data. The latter process is particularly important in view of the use of model plants in the financial analysis. In practice, actual plants will deviate from the model and these variances will be considered in interpreting financial results based on model plants.

A. Fundamental Methodology

Much of the underlying analysis regarding price, financial, and production effects is common to each kind of impact. Consequently, this case methodology is described here as a unit with the specific impact interpretations being discussed under the appropriate headings following this section.

The core analysis for this inquiry was based upon synthesizing physical and financial characteristics of the various industry segments through model or representative plants. The estimated cash flows for these model plants were summarized in Chapter II. The primary factors involved in assessing the financial and production impact of pollution control are profitability changes, which are a function of the cost of pollution control and the ability to pass along these costs in higher prices. Admittedly, in reality, closure decisions are seldom made on a set of well defined common economic rules. They include a wide range of personal values, production unit within an integrated larger cost center.

Such circumstances include but are not limited to the following factors:

1. There is a lack of knowledge on the part of the owner-operator concerning the actual financial condition of the operation due to faulty or inadequate accounting systems or procedures. This is especially likely to occur among small, independent operators who do not have effective cost accounting systems.

2. Plant and equipment are old and fully depreciated and the owner has no intention of replacing or modernizing them. He can continue in production as long as he can cover labor and materials costs and/or until the equipment deteriorates to an irreparable and inoperative condition.

3. Opportunities for changes in the ownership structure of the plants (or firms) exist through the acquisition of the plants by grower cooperatives where the principal incentive is that of maintaining sugar cane acreages in situations where grower returns from sugar cane production are substantially above returns from alternative opportunities. In this situation, which presently exists in the cane sugar industry, growers may elect to form producer-processor cooperatives and acquire ownership of processing plants which they would continue to operate at levels of return generally unattractive to private owners.

4. Personal values and goals associated with business ownership that overrride or ameliorate rational economic rules is a complex of factors commonly referred to as a value of psychic income.

5. The plant is a part of a larger integrated entity and it either uses raw materials being produced profitably in another of the firm's operating units wherein an assured market is critical or, alternatively, it supplies raw materials to another of the firm's operations wherein the source of supply is critical. When the profitability of the second operation offsets the losses in the first plant, the unprofitable operation may continue indefinitely because the total enterprise is profitable.

6. The owner-operator expects that losses are temporary and that advertised conditions will dissipate in the future. His ability to absorb short-term losses depends upon his access to funds, through credit or personal resources not presently utilized in this particular operation.

7. There are very low (approaching zero) opportunity costs for the fixed assets and for the owner-operator's managerial skills and/or labor. As long as the operator can meet labor and materials costs, he will continue to operate. He may even operate with gross revenues below variable costs until he has exhausted his working capital and credit.

8. The value of the land on which the plant is located is appreciating at a rate sufficient to offset short-term losses, funds are available to meet operating and opportunity costs if the owner-operator's managerial skills are low.

The above factors, which may be at variance with common economic decision rules, are generally associated with proprietorships and closely held enterprises rather than publicly held corporations.

While the above factors are present in and relevant to business decisions, it is argued that common economic rules are sufficiently universal. To provide an useful and reliable insight into potential business responses to new investment decisions, as represented by required investment in pollution control facilities, economic analysis will be used as the core analytical procedure. Given the pricing conditions, the impact on profitability (and possible closure) can be determined by simply computing the ROI (or any other profitability measure) under conditions of the new price and incremental investment in pollution control. The primary consequence of profitability changes is the impact on the plant in terms of a plant shutdown rather than making the required investment to meet pollution control requirements.

In the most fundamental case, a plant will be closed when variable expenses (Vc) are greater than revenues (R), since by closing the plant losses can be avoided. However, in practice, plants continue to operate where apparently Vc > R. Reasons for this include:

- lack of cost accounting detail to determine when Vc > R.
- opportunity cost of labor or some other resource is less than market values. This would be particularly prevalent in proprietorships where the owner considers his labor as fixed.
- other personal and external financial factors.
- expectations that revenues will shortly increase to cover variable expenses.

A more probable situation is the case where Vc < R but revenues are less than variable costs plus cash overhead expenses (TCc) which are fixed in the short run. In this situation a plant would continue to operate as long as contributions are being made toward covering a portion of these fixed cash overhead expenses. The firm cannot operate indefinitely under this condition, but the length of this period is uncertain. Basic to this strategy of continuing operations is the firm's expectation that revenues will increase to cover cash outlays. Factors involved in this type of closure decision include:

- extent of capital resources. If the owner has other business interests or debt sources that will supply capital input, the plant will continue.
- lack of cost accounting detail or procedures to know that TCc > R, particularly in multiplant business situations.
- labor or other resources may be considered fixed and the opportunity cost for these items is less than market value.

Identification of plants where TCc > R but VC < R leads to an estimate of plants that should be closed over some period of time if revenues do not increase. However, the timing of such closures is difficult to predict.

The next level of analysis, where TCc < R, involves estimating the earnings before and after investment in pollution abatement. So long as TCc < R it seems likely that investment in pollution control will be made and plant operation continued so long as the capitalized value

of earnings (CV), at the firm's (industry) cost of capital is greater than the scrap or salvage value (S) of the sunk plant investment. If S > CV, the firm could realize S in cash and reinvest and be financially better off. This presumes reinvesting at least at the firm's (industry) cost of capital.

Computation of CV involves discounting the future earnings flow to present worth through the general discounting function:

$$V = \sum_{n=1}^{t} A_n(1+i)^{-n}$$

where:

V = present value
A_n = a future value in n^{th} year
i = discount rate as target ROI rate
n = number of conversion products, i.e., 1 year, 2 years, etc.
t = terminal number (or year)

It should be noted that a more common measure of rate of return is the book rate, which measures the after-tax profits as a ratio of invested capital, net worth, or sales. These ratios should not be viewed as a different estimate of profitability as opposed to DCF (discounted cash flow) measures but rather as an entirely different profitability concept. The reader is cautioned not to directly compare the DCF rates with book rates. Although both measures will be reported in the analyses, the book rate is reported for informational purposes only.

The two primary types of DCF measures of profitability are used. One is called the internal rate of return or yield and is the computed discount rate (yield) which produces a zero present value of the cash flow. The yield is the highest rate of interest the investor could pay if all funds were borrowed and the loan was returned from cash proceeds of the investment. The second DCF measure is the net present value concept. Rather than solve for the yield, a discount rate equivalent to the firm's cost of capital is used. Independent investments with net present values of above zero are accepted; those below zero are rejected. The concept of comparing capitalized earnings with the sunk investment value is a variation of the net present value method.

The data input requirements for book and DCF measures are derived, to a large extent, from the same basic information although the final inputs are handled differently for each.

1. Benefits

For purposes of this analysis, benefits for the book analysis have been called after-tax income and for the DCF analysis after-tax cash proceeds. The computation of each is shown below:

$$\text{After tax income} = (1 - T) \times (R - E - I - D)$$

$$\text{After tax cash proceeds} = (1 - T) \times (R - E - D) + D$$

where:

T = tax rate

R = revenues

E = expenses other than depreciation and interest

I = interest expense

D = depreciation charges

Interest in the cash proceeds computation is omitted since it is reflected in the discount rate, which is the after-tax cost of capital, and will be described below. Depreciation is included in the DCF measure only in terms of its tax effect and is then added back so that a cash flow over time is obtained.

A tax rate of 48 percent was used throughout the analysis. Accelerated depreciation methods, investment credits, and carry forward and carry back provisions were not used due to their complexity and special limitations. It is recognized that in some instances the effective tax rate may be lower for single plant, but with the dominance of multiplant firms, the industry's tax rate will be close to the 48 percent rate.

Revenue, expenses, interest and depreciation charges used were those discussed in Chapter II. Chapter V discusses the cost of pollution control facilities. These items were assumed to be constant over the period of anlaysis.

2. Investment

Investment is normally thought of as outlays for fixed assets and working capital. However, in evaluating closure of an on-going plant where the basic investment is sunk, the value of that investment must be analyzed in terms of its liquidation or salvage value, that is its opportunity cost or shadow price.1/ For purposes of this analysis sunk investment was taken as the sum of equipment salvage value plus land at book value plus the value of the net working capital (current assets less current liabilities) tied up by the plant (see Chapter II for values). This same amount was taken as a negative investment in the terminal year. Replacement investment for plant maintenance was taken as equal to annual depreciation, which corresponds to operating policies of some managements and serves as a good decision rule for replacement in an on-going business.

Investment in pollution control facilities was taken as the estimates provided by EPA and shown in Chapter V. Only incremental values were used to reflect in-place facilities. The value of the land involved was taken as a negative investment in the terminal year.

The above discussion refers primarily to the DCF analysis. Investment used in estimating book rates was taken as invested capital -- book value of assets plus net working capital. In the case of new investment, its book rate was estimated as 50 percent of the original value.

3. Cost of Capital After Tax

Return on invested capital is a fundamental notion in U.S. business. It provides both a measure of actual performance of a firm as well as expected performance. In this latter case, it is also called the cost of capital. The cost of capital is defined as the weighted average of the cost of each type of capital (equities and interest bearing liabilities) employed by the firm. There is no methodology that yields the precise cost of capital, but it can be approximated within reasonable bounds.

The cost of equities was estimated by two methods -- the dividend yield method and the earnigs stock price (E/P ratio) method. Both are simplifications of the more complex DCF methodology. The dividend method is:

1/ This should not be confused with a simple buy-sell situation which merely involves a transfer of ownership from one firm to another. In this instance, the opportunity cost (shadow price) of the investment may take on a different value.

$$k = \frac{D}{P} + g$$

where:

k = cost of capital
D = dividend yield
P = stock price
g = growth

and the E/P method is simply

$$k = E/P$$

where:

k = cost of capital
E = earnings
P = stock price

and is a further simplification of the first. The latter assumes future earnings as a level, perpetual stream.

The after tax cost of debt capital was estimated by using reported interest costs as a percent of total debt and multiplying by .52 -- assuming a 48 percent tax rate. These values were weighted by the respective equity to total asset and total liabilities[1/] to total asset ratios.

4. Construction of the Cash Flow

A twenty-two period cash flow was used in this analysis and was constructed as follows:

1. Sunk investment (salvage market value of fixed assets plus net working capital) taken in year t_0.

2. After tax cash proceeds taken for years t_1 to t_{20}.

3. Annual replacement investment equal to annual current depreciation taken for years t_1 to t_{20}.

4. Terminal value equal to sunk investment taken in year t_{21}.

5. Incremental pollution control investment taken in year t_0 for 1977 standards and year t_6 to 1983 standards.

6. Incremental pollution expenses taken for years t_1 to t_{20} for 1977 standards and years t_7 to t_{20} for 1983 standards, if additive to the 1977 standards.

[1/] It is recognized that liabilities contain non-interest bearing liabilities, but their weight is believed to be an adequate estimate of the weight of debt since such liabilities are usually insignificant.

7. No replacement investment taken on incremental pollution investment on the assumption of a 20 year life.

8. No terminal value of pollution facilities was taken in year t_{21}. Often land would be taken, but because it represents such a small quantity, the value was ignored.

B. Price Effects

At the outset, it must be recognized that price effects and production effects are intertwined with one effect having an impact upon the other. In fact, the very basis of price analysis is the premise that prices and supplies (production) are functionally related variables which are simultaneously resolved.

Solution of this requires knowledge of demand growth, price elasticities, supply elasticities, the degree to which regional markets exist, the degree of dominance experienced by large firms in the industry, market concentration exhibited by both the industry's suppliers of inputs and purchasers of outputs, organization and coordination within the industry, relationship of domestic output with world market, existence and nature of complementary goods, cyclical trends in the industry, current utilization of capacity and, exogenous influences upon price determination (e.g., governmental regulation).

In view of the complexity and diversity of factors involved in determination of the market price, a purely quantitative approach to the problem of price effects was not feasible. Hence, the simultaneous considerations suggested above were made. The judgment factor was heavily employed in determining the supply response to a price change and alternative price changes to be employed.

As a guide to the analysis of price effects, the estimated price required to leave the model plant segment as well off as it is today was computed. The required price increase at the firm level was evaluated in light of the relationship of the model plant to the industry and the understanding of the competitive position of the industry. The required price increase was computed using the DCF analysis described above, but dealing only with the incremental pollution investment and cash proceeds.

Application of the above DCF procedure to these costs yielded the present value of pollution control costs (i.e., investment plus operating cost less tax savings). The price increase required to pay for pollution control was calculated by the formula:

$$X = \frac{(PVP)(100)}{(1-T)(PVR)}$$

where:

X = required percentage increase in price

PVP = present value of pollution control costs

PVR = present value of gross revenue starting in the year pollution control is imposed.

T = tax rate

Note that this formula implies that incremental profits resulting from the price increase will be taxed at a rate of 48 percent.

C. Financial Effects

In Chapter II, the financial characteristics of model plants were presented. These data served as the base point for the analysis of financial effects of pollution control. The primary focus of analysis was upon profitability in the industry and the ability of the firms to secure external capital. Hence, it is obvious that this portion of the analysis could not be divorced from production effects since profit levels and the ability to finance pollution abatement facilities have a direct influence on supply responses -- utilization of capacity and plant closures.

The measures of profitability utilized included after-tax book rate of return on invested capital and cash flow (after-tax profit plus depreciation). After-tax profit as a percent of sales was also reported to assist in comparing financial data with standard industrial measures.

In addition to these factors, two additional measures of economic profitability were examined: (1) capitalized value of earnings and (2) present values estimated by the procedures described in Section A above. Both of these measures were calculated on a pre- and post-pollution control bases.

Given these financial measurements, the ability of the industry to finance the required pollution control expenditures was reexamined in light of the financial results and the information shown in Chapter II. This ability will vary from one industry subsector to another due to different financial structures, profitability, and abatement requirements. Hence, capital availability and cost was examined on a model plant basis.

D. Production Effects

Potential production effects include reductions of capacity utilization rates, plant closures and stagnation of industry growth. Reductions in capacity utilization were estimated via qualitative techniques given the analysts' knowledge of the industry. The same was true for assessing the extent to which plant closures may be offset by increases in capacity utilization on the part of plants remaining in operation. Data limitations and time constraints required that the impact of pollution control standards upon future growth of the industry also be estimated via qualitative methods.

The remaining effect, plant closures, is very difficult to measure realistically as discussed above in Section A. As a starting point in the plant closure analysis, a shutdown model was employed to indicate which model plants should be closed, the marginal operations and the sound operations. These conclusions were based upon the decision rule that a plant will be closed when the net present value of the cash flow is less than zero.

It is recognized that the use of models to represent an industry is imperfect and that not all of the relevant values or factors can be included in the models. Hence, in this industry, the appropriate model plant results were equated with each cane sugar plant and the variances from the model plant parameters were subjectively evaluated to arrive at an estimate of the probability of closure. In Chapter VI a list of the 6 model parameters are shown against which each plant in the industry was compared.

The above analysis was done under a "without pollution" control condition and a "with pollution" control condition. The former (and including historical trends) established a baseline against which total closures after pollution control were compared to arrive at an estimate of closures due to pollution control.

E. Employment Effects

Given the production effects of estimated production curtailments, plant closings and changes in industry growth, a major consideration arises in the implications of these factors upon employment in the industry. The employment effects stemming from each of these production impacts were estimated. To the extent possible, the major employee classifications involved were examined with respect to the potential for re-employment.

F. Community Effects

The direct impacts of job losses upon a community were apparent. However, in many cases, plant closures and cutbacks have a far greater impact than just the employment lost. Multiplier effects may result in even more unemployment. Badly needed taxes for vital community services may dwindle. However, in some cases, the negative community aspects of production effects may be very short-term in nature with the total impact barely visible from the viewpoint of the overall community. In a few cases, the closure of a plant may actually be viewed as a positive net community effect (e.g., a small plant with a high effluent load in an area with a labor shortage). These impact factors were qualitatively analyzed as appropriate.

G. Other Effects

Other impacts such as direct balance of payments effects were also qualitatively analyzed.

V. POLLUTION CONTROL REQUIREMENTS AND COSTS

Water pollution control standards, technology and costs used in this analysis were provided by the Environmental Protection Agency. The conclusions of this report are based on those costs. During the preparation of this report, a number of changes were introduced by EPA but the contractor believes that the cost figures and investment amounts shown in the analytical portion of this report are current. Several factors, however, have been spelled out in the limits to this analysis which bear specifically on the information and costs as provided by EPA. Further, it should be noted that the information shown below refers specifically to cane sugar refineries. Sugar cane milling costs and impacts are not shown and are not to be considered at this time.

A. Alternative Effluent Control Levels

General levels of pollution control for the liquid sugar segment and the crystalline sugar segment of the cane sugar refining industry are set forth below. Each of these levels indicate an effluent discharge, and the loadings for this discharge in BOD and Suspended Solids are shown in Table V-1.

1. Alternative A: No waste treatment or control. Essentially the effluent from this alternative is raw effluent, and there is neither treatment nor cost involved in this alternative.

2. Alternative B: Elimination of discharge from filters. This alternative can be achieved by either (1) impounding the mud resulting from slurrying the filter cake with water or (2) by dry hauling the desweetened filter cake to land fill. B-1 assumes that the filter slurry is impounded, and B-2 assumes dry disposal of the filter cake.

3. Alternative C: Inplant modifications to reduce the entrainment of sucrose into condenser water. This alternative includes the installation of the demisters and external separators in order to reduce the entrainment of sucrose in condenser water. In addition, refineries have good baffling and operation controls in the evaporators and vacuum pans as well as good vapor height.

Table V-1. Summary of waste loads from effluent treatment alternatives for cane sugar refineries

Alternative	Liquid		Crystalline	
	BOD	SS	BOD	SS
	---- kilograms per metric ton ------			
A	3.725	8.90	1.85	9.20
B	3,25	1.00	1.375	1.30
C	2.90	1.00	1.16	1.30
D*	0.32	0.17	0.43	0.09
E**	0.15	0.03	0.09	0.035
F	0.15	0.00	0.34	0.00
G	0.00	0.00	0.00	0.00

* BPT
** BAT; NSPS

Source: Development Document for Effluent Limitations Guidelines and New Source Performance Standards for the Cane Sugar Refining Segment of the Sugar Processing Industry, Environmental Protection Agency, March 1974.

4. Alternative D: Biological treatment of process water. This alternative assumes the use of an activated sludge plant to treat process water in addition to the treatment under Alternative B and C. While there are presently no refineries which have their own biological treatment systems, the process waste water is highly bio-degradable and, thus, well suited for biological treatment in the opinion of the Development Document as furnished by EPA.

5. Alternative E: Recycling of condenser water and biologically treating blowdown. This alternative includes, in addition to Alternative D, the recycling of condenser water followed by biological treatment of the blowdown in an activated sludge unit. The blowdown is to be approximately two percent of the total flow. Recycling the condenser water cools the water, and thus removes the heat normally discharged and, (2) concentrates the waste loadings into the smaller blowdown stream, making biological treatment of this waste stream feasible. Alternative E-1 assumes a cooling tower. Alternative E-2 assumes a spray pond. Furthermore, where the E technology is used in conjunction with Alternative D, a sand filter must also be added at the end of the line for removal of suspended solids.

Table V-2 presents a summary of the final effluent limitations guidelines. Crystalline refineries which discharge both barometric condenser cooling water and other process waters shall meet the BPT limitations (1977) a daily maximum of 1.19 Kg of BOD_5 per KKg of melt and a daily average of 0.43 KKg of BOD_5 per KKg of melt for any 30-day period. Crystalline refineries discharging only barometric condenser cooling water have a limitation of 1.02 Kg of BOD_5 (daily maximum) and 0.34 KKg of BOD_5 (daily average). All crystalline refineries have BPT limitations for total suspended solids of 0.27 (daily maximum) and 0.09 (daily average) Kg/KKg of melt. BAT (1983) and NSPS (1974) limitations for crystalline refineries are identical. They are 0.18 (daily maximum) and 0.09 (daily average) Kg of BOD_5 per KKg of melt and 0.11 (daily maximum) and 0.035 (daily average) Kg of TSS per KKg of melt.

Liquid refineries have different limitations. For BPT, those discharging both barometric condenser cooling water and other process waters have BOD_5 limitations of 0.78 (daily maximum) and 0.32 (daily average) Kg/KKg of melt and TSS limitations of 0.50 and 0.17 Kg/KKg of melt (daily maximum and daily average respectively. The BOD_5 limitations are reduced to 0.45 and 0.15 for refineries discharging only barometric condenser cooling water. BAT and NSPS limitations are 0.30 (daily maximum) and 0.15 (daily average) Kg of BOD_5 per KKg of melt and 0.09 and 0.03 Kg of TSS per KKg of melt.

4. Alternative D: Biological treatment of process water. This alternative assumes the use of an activated sludge plant to treat process water in addition to the treatment under Alternative B and C. While there are presently no refineries which have their own biological treatment systems, the process waste water is highly bio-degradable and, thus, well suited for biological treatment in the opinion of the Development Document as furnished by EPA.

5. Alternative E: Recycling of condenser water and biologically treating blowdown. This alternative includes, in addition to Alternative D, the recycling of condenser water followed by biological treatment of the blowdown in an activated sludge unit. The blowdown is to be approximately two percent of the total flow. Recycling the condenser water cools the water, and thus removes the heat normally discharged and, (2) concentrates the waste loadings into the smaller blowdown stream, making biological treatment of this waste stream feasible. Alternative E-1 assumes a cooling tower. Alternative E-2 assumes a spray pond. Furthermore, where the E technology is used in conjunction with Alternative D, a sand filter must also be added at the end of the line for removal of suspended solids.

Table V-2 presents a summary of the final effluent limitations guidelines. Crystalline refineries which discharge both barometric condenser cooling water and other process waters shall meet the BPT limitations (1977) a daily maximum of 1.19 Kg of BOD_5 per KKg of melt and a daily average of 0.43 KKg of BOD_5 per KKg of melt for any 30-day period. Crystalline refineries discharging only barometric condenser cooling water have a limitation of 1.02 Kg of BOD_5 (daily maximum) and 0.34 KKg of BOD_5 (daily average). All crystalline refineries have BPT limitations for total suspended solids of 0.27 (daily maximum) and 0.09 (daily average) Kg/KKg of melt. BAT (1983) and NSPS (1974) limitations for crystalline refineries are identical. They are 0.18 (daily maximum) and 0.09 (daily average) Kg of BOD_5 per KKg of melt and 0.11 (daily maximum) and 0.035 (daily average) Kg of TSS per KKg of melt.

Liquid refineries have different limitations. For BPT, those discharging both barometric condenser cooling water and other process waters have BOD_5 limitations of 0.78 (daily maximum) and 0.32 (daily average) Kg/KKg of melt and TSS limitations of 0.50 and 0.17 Kg/KKg of melt (daily maximum and daily average respectively. The BOD_5 limitations are reduced to 0.45 and 0.15 for refineries discharging only barometric condenser cooling water. BAT and NSPS limitations are 0.30 (daily maximum) and 0.15 (daily average) Kg of BOD_5 per KKg of melt and 0.09 and 0.03 Kg of TSS per KKg of melt.

Table V-2. Effluent Limitations guidelines for cane sugar refineries

	Crystalline Refining				Liquid Refining			
	BOD_5		TSS		BOD_5		TSS	
	Daily Max.	Daily Average[1/]	Daily Max.	Daily Average[1/]	Daily Max.	Daily Average[1/]	Daily Max.	Daily Average[1/]
	Kg/KKg of melt				Kg/KKg of melt			
BPT								
(a) Both barometric condenser and other process water	1.19	0.43	0.27	0.09	0.78	0.32	0.50	0.17
(b) Barometric condenser only	1.02	0.34	0.27	0.09	0.45	0.15	0.50	0.17
BAT and NSPS	0.18	0.09	0.11	0.035	0.30	0.15	0.09	0.03

[1/] Average of daily values for thirty consecutive days

Source: Development Document for Effluent Limitation Guidelines and New Source Performance Standards for the Cane Sugar Refining Segment of the Sugar Processing Industry, Environmental Protection Agency, March, 1974.

B. Current Level of Control

The current control technologies being used by the cane sugar refineries may be discerned by an examination of Tables V-3 and 4 which indicate such controls by plant type, size, and classification.

Table V-5 indicates the type and extent of treatment of process and condenser water at each specific refinery. While it was not possible to translate each of the descriptions into specific alternative levels of technology, the data are a reasonable estimate of inplace technology. For each of the cane sugar refineries, a designation of the current status of inplace control is shown in Table V-5.

This table indicates that 16 plants currently either discharge their process water to a municipal system or employ such technologies that there is effectively no discharge of effluent from the process water to surface water bodies. Only five plants either treat their condenser water or discharge it to a municipal system; thus, the needed treatment for condenser water is a major consideration in increased effluent. Supportive of this position is the fact that there are 14 plants that discharge condenser water after making only one pass through the condenser.

C. Water Pollution Abatement Costs

The costs of the various alternatives of treatment from B through E were furnished by the Environmental Protection Agency through Supplement A of the Development Document for Effluent Limitations Guidelines. Table V-6 shows a summary of these costs for both liquid and crystalline plants and shows the incremental investment and annual cost of operation involved for each level of treatment. As noted in Table V-1, Alternative D must be achieved by 1977 for BPT standards and Alternative E must be achieved by 1983 for BAT standards.

1. Investment

The estimates on investment for each level of technology were taken as received from EPA and the conclusions, as far as the impact of costs shown in the next chapter, follow from these estimates.

The assumption was made that B-1 or B-2 was in place for most refineries; therefore, the investment for the B-1 or B-2 technology were used only in evaluating one refinery in Table V-7. The need for Alternative C technology, involving various entrainment devices for the vacuum pans and the evaporators, was not clearly indicated; however because the amount of investment for Alternative C is but a minor part of the total investment compared to that for D and E levels, the absence of such data is not serious.

Table V-3. Summary of wastewater treatment and disposal techniques of United States cane sugar refineries 1/

Refinery	Disposal of Wastewaters
C-1	All process wastewater to municipal sewers; condenser water to river.
C-2	All process wastewater to municipal sewers; condenser water to river.
C-3	All liquid wastes to river.
C-4	All process wastewater to municipal sewers; condenser water to river.
C-5	All process wastes to municipal sewers; condenser water to river.
C-6	All liquid wastes to river.
C-7	Primary settling of process wastes; all discharge to river.
C-8	All liquid wastes currently to river. Hook up to municipal system completed for process water and expected to be operational before 1977.
C-9	Most process wastewater to municipal sewers; condenser water to river.
C-10	Most process wastewater to municipal sewers; condenser water to river.
C-11	Discharge process water into a swamp after traveling through a two and a half mile canal.
C-12	Total impoundment of wastewater resulting in no discharge to navigable waters.
C-13	Discharge into a swamp.
C-14	All process wastes to municipal sewers; recycle of condenser water through a cooling tower and discharge of blowdown to municipal sewers.

Table V-3. Summary of wastewater treatment and disposal techniques of United States cane sugar refineries (continued)

Refinery	Disposal of Wastewaters
L-1	All liquid wastes to municipal sewers.
L-2	All liquid wastes to municipal sewer; condenser water to river.
L-3	All process wastewater to municipal sewer; condenser water to river.
L-4	Total impoundment of wastewaters resulting in no discharge to navigable waters.
L-5	Discharge of process water; cooling tower for condenser water.
CL-1	All process wastewater to municipal sewers; condenser water to river.
CL-2	Most of process wastes to municipal sewers; condenser water to river.
CF-1	Closed system of canals and holding ponds resulting in no discharge to navigable waters.
CF-2	Total impoundment of acid/caustic wastes and filter cake slurry; impoundment with overflow of all other wastewaters.
CF-3	Condenser water passed through spray pond (partial recycle possible) before discharge; all process wastewaters discharged to impoundage.
CF-4	Condenser water impounded then discharged; all other waters impounded completely in ponds; cooling tower recently built.
CF-5	Partial impoundment.
CF-6	Partial reuse of wastewaters in raw sugar factory for cane washings during grinding season.
CF-7	Partial impoundment.
CF-8	Partial impoundment.

Source: Development Document for Effluent Limitation Guidelines and New Source Performance Standards for the Cane Sugar Refining Segment of the Sugar Processing Industry, Environmental Protection Agency, March, 1974.

Table V-4. Cane sugar refineries, code, capacity and classification

Code	Capacity ton/day	Type of Refinery	Classification 1/
C-1	2,600	Crystalline	4
C-2	2,100	"	4
C-3	3,250	"	4
C-4	2,100	"	4
C-5	1,000	"	4
C-6	190	"	2
C-7	3,500	"	4
C-8	1,500	"	4
C-9	2,000	"	4
C-10	1,200	"	4
C-11	1,500	"	3
C-12	350	"	2
C-13	1,700	"	3
C-14	2,200	"	4
L-1	300	Liquid	1
L-2	800	"	1
L-3	850	"	1
L-4	390	"	1
L-5	100	"	1
CL-1	1,800	Crystalline-Liquid	4
CL-2	820	"	4
CF-1	460	Ref.-Mill	2
CF-2	700	"	3
CF-3	660	"	2
CF-4	700	"	3
CF-5	220	"	2
CF-6	600	"	2
CF-7	400	"	2
CF-8	700	"	2

1/ Classification refers to model segment:

1 - Liquid
2 - Small rural crystalline
3 - Large rural crystalline
4 - Urban crystalline

Table V-5. Cane sugar refineries, water effluent discharge status

Code	Process water				Condenser water				
	No Treatment	Municipal system	Partial Treatment	Total Treatment	Direct discharge to water bodies	Municipal system	Partial Treatment	Cool and Recycle	Total Treatment
C-1		X			X				
C-2		X			X				
C-3	X				X				
C-4		X			X				
C-5		X			X				
C-6	X				X				
C-7		1/	X		X				
C-8			X		X				
C-9		X 2/			X				
C-10		X 2/			X				
C-11			X 3/				X		
C-12				X					X
C-13			X 3/				X		
C-14		X				X			
L-1		X				X			
L-2		X			X				
L-3		X			X				
L-4				X					X
L-5	X							X	
CL-1		X			X				
CL-2		X 2/			X				
CF -1				X					X
CF -2				X			X		
CF -3				X			X		
CF -4				X			X		
CF -5			X				X		
CF -6			X				X		
CF -7			X				X		
CF -8			X				X		

1/ Expect to be on municipal hookup by the end of 1973

2/ Most process water to a municipal system

Discharge to a swamp - not to a navigable river.

Table V-6. Cane sugar refinery water pollution control investment and annual costs [1] by technologies

	A	B-1	B-2	C	D	E-1	E-1 [3]	E-2	E-2 [3]
					$1,000				
Liquid									
Investment	0	33.0	66.0	58.0	362.0	157.0	187.0	133.0	163.0
Annual cost [2]	0	6.2	39.5	23.6	145.9	18.4	20.0	15.5	17.1
Crystalline									
Small									
Investment	0	35.5	66.0	56.0	273.0	339.0	371.9	270.0	302.9
Annual cost [2]	0	5.8	39.5	20.3	127.6	46.4	48.0	40.6	42.1
Large									
Investment	0	71.0	66.0	79.0	712.0	709.0	766.0	584.0	640.0
Annual cost [2]	0	15.0	68.5	25.1	169.1	109.0	113.4	87.7	92.1

[1] All costs updated from 1971 to 1972 by use of 1.076 multiplier.

[2] Annual maintenance and operating cost less depreciation and interest.

[3] Includes cost of sand filter.

Source: Development Document for Effluent Limitations Guidelines and Standards of Performance: Cane Sugar Refining Segment of Sugar Processing Industry - Supplement A, Cost Analysis. Environmental Protection Agency

able V-7. Cane sugar refineries estimated technology needs and costs to meet best practical control technology currently available

Code	Capacity ton/day	B-1 [1] Investment	B-1 [1] Annual Cost	B-2 [1] Investment	B-2 [1] Annual Cost	C Investment	C Annual Cost	D Investment	D Annual Cost	Total Investment	Total Annual Cost
						$000					
-1	2,600										
C-2	2,100										
C-3	3,250	71	15.0					711	169.1	782	184.1
-4	2,100										
-5	1,000										
C-6	190	(Municipal hookup anticipated)									
C-7	3,500					79	25.1	711	169.1	790	194.2
-8	1,500										
-9	2,000					79	25.1			79	25.1
C-10	1,200					79	25.1			79	25.1
C-11	1,500							711	169.1	711	169.1
-12	350										
-13	1,700							711	169.1	711	169.1
C-14	2,200										
-1	350										
L-2	800					58	23.6			58	23.6
L-3	850					58	23.6			58	23.6
-4	390										
-5	100					58	23.6	362	145.9	420	169.5
CL-1	1,000										
L-2	820					56	20.3			56	20.3
CF-1	460										
CF-2	700					56	20.3			56	20.3
F-3	660					56	20.3			56	20.3
F-4	700					56	20.3			56	20.3
CF-5	220					56	20.3	273	127.6	329	147.9
CF-6	600					56	20.3	273	127.6	329	147.9
F-7	400					56	20.3	273	127.6	329	147.9
F-8	700					56	20.3	273	127.6	329	147.9
Totals		71	15.0	0	0	859	308.5	4,298	1,332.7	5,228	1,656.2
No. of Refineries		1		0		14		9		18	

[1] Arbitrarily B-1 costs we assumed for rural and B-2 costs for urban refineries.

Table V-7 shows the various refineries that require investment and expense to meet the BPT level (Alternatives B through D) and Table V-8 shows what incremental investments and expenses need to be made by 1983 in order to achieve the BAT level of control (Alternative E).

2. Operating and Ownership Costs

In contrast to those for the beet sugar industry, the cane sugar refining industry's operating and maintenance costs are a significant part of the total costs of water pollution control equipment and practices as compared to the total cost of investment. As will be seen later, the amount of annual expense does have a significant impact on the refineries and affects the discounted cash flow analysis. Annual depreciation charges of five percent were taken on equipment on the presumption that this equipment would have a 20-year life and no salvage value.

3. Estimated Costs

The above data made possible a total cost estimate for each refinery. For the purposes of the impact analysis this cost information was then blended in with each model plant in order to measure the impact on a plant-by-plant basis. Overall industry costs for BPT levels of treatment are $5,567,000. For BAT levels, an additional $11,120,000 will be required.

These costs, as previously mentioned, assume that the levels of technology specified will produce the level of treatment required to meet the guidelines and, secondly, that the alternatives of treatment are properly costed so that these do, in fact, represent actual dollars to be spent by each refinery. Of the 29 refineries, 17 will be required to invest money by 1977, and a total of 22 will be investing in water pollution control by 1983.

Table V-8. Cane sugar refineries estimated technology needs and costs to meet best available technology economically achievable - 1972 data

Code	Capacity ton/day	E-1 [1] Investment	E-1 [1] Annual Cost	E-2 [1] Investment	E-2 [1] Annual Cost	Total Investment	Total Annual Cost
				$000			
C-1	2,600	709	109.0			709	109.0
C-2	2,100	709	109.0			709	109.0
C-3	3,250	766	113.4			766	113.4
C-4	2,100	709	109.0			709	109.0
C-5	1,000	709	109.0			709	109.0
C-6	190	(Municipal hookup anticipated)					
C-7	3,500	766	113.4			766	113.4
C-8	1,500	709	109.0			709	109.0
C-9	2,000	709	109.0			709	109.0
C-10	1,200	709	109.0			709	109.0
C-11	1,500			640	92.1	640	92.1
C-12	350					0	
C-13	1,700			640	92.1	640	92.1
C-14	2,200					0	
L-1	300					0	
L-2	800	157	18.4			157	18.4
L-3	850	157	18.4			157	18.4
L-4	390					0	
L-5	100	28	1.5 [2]			28	1.5
CL-1	1,800	709	109.0			709	109.0
CL-2	820	339	46.4			339	46.4
CF-1	460					0	
CF-2	700			270	40.6	270	40.6
CF-3	660						
CF-4	700	170	23.2 [3]			170	23.2
CF-5	220			303	42.1	303	42.1
CF-6	600			303	42.1	303	42.1
CF-7	400			303	42.1	303	42.1
CF-8	700			303	42.1	303	42.1
Totals		8,055	1,206.7				
No. of Refineries		15					

[1] Arbitrarily E-1 costs were assumed for urban and E-2 costs for rural refineries.

[2] Has cooling tower - needs only sand filtration.

[3] Has cooling tower with half capacity now. Therefore only one half cost of an additional cooling tower is used.

VI. IMPACT ANALYSIS

The impacts considered in this analysis include the following:

- Price effects
- Financial effects
- Production effects
- Employment effects
- Community effects
- Balance of payments effects

A comprehensive and detailed analysis of each of the above was beyond the scope of this study; consequently, emphasis was given to the financial and plant closure analyses.

A. Price Effects

Estimated price increases necessary for the industry to maintain its current level of profitability are not large, although certain segments will require much higher increases than others. Table VI-1 shows estimated price increases required to maintain estimated current profitability levels based on the model plant analysis. It shows the incremental increases involved in the BPT level, the BAT level, and the total of both, which would be required by 1983.

Except for the segment of refineries listed as "small, rural," all price increases needed are less than one percent. The liquid plants need the least price increase, only .14 of one percent. The small, rural plants, (and, then, only some), show a need for a 2.07 percent increase; the large, rural a .92 of one percent; and the urban plants require a .61 of one percent increase. Five plants, which require no treatment cost whatsoever, represent 11 percent of the total refinery capacity. Approximately 89 percent of the industry does not currently meet the required control standards.

In comparison, the sugar beet refinery industry, because of its proportion of plants operating at zero discharge, will need additional investments in only 30 percent of its plants. The needed price increases to compensate for control costs are approximately equal for both industries.

Since the demand for sugar at the household level is relatively inelastic, we doubt that such price increases would alter this consumption pattern significantly. Although price elasticities for industrial users and cross elasticities with other sweeteners, such as beet sugar, corn sweeteners, and synthetics, are not known with certainty, there appears to be a possibility that sugar itself, both beet and cane, could become

Table VI-1. Percentage price increases needed to maintain profitability

Model	BPT		BAT		Total increase by '83	
	Min.	Max.	Min.	Max.	Min.	Max.
Liquid	0	0	0	.14	0	.14
Crystalline						
Small rural	0	1.74	0	.33	0	2.07
Large rural	0	.68	0	.24	0	.92
Urban	0	.44	.16	.16	.16	.61

less competitive. Because of this price pressure, some companies may withdraw from specific markets in which they compete at a disadvantage and, thus, independently satisfy their need for price increases. Recently, for instance, Holly Sugar, a beet sugar company, announced its withdrawal from the low-priced Chicago market since it did not have enough sugar to compete in all markets.

However, under present legislation, sugar's ultimate competitive position will depend upon the Department of Agriculture's policy regarding such costs and how these are interpreted in relation to import quotas. Objectives of the Sugar Act, discussed in Chapter III, suggest that pollution control costs could receive some consideration, but again such decisions are made by the Secretary of Agriculture under the broad rather than the specific powers in the Act.

Section 205 of the Act entitled "Allotmets of Quotas or Prorations" states that the Secretary of Agriculture shall make allotments to assure an orderly and adequate flow of sugar to prevent disorderly marketing or importation and to maintain a continuous and stable supply of sugar so as to afford all interested persons an equitable opportunity to market sugar. It seems that, under this section, the Secretary could make adjustments in quotas to adjust for increased costs of pollution. However, in doing so, it is suspected that the Secretary would take into account the cost of impacts of pollution control in both the beet and cane sugar industries. In doing so the Secretary could be constrained to variances in the price of some three or four percent, as defined in Section 202 of the Act.

Thus, an important factor for price changes in response to the imposition of pollution controls appears to be the position which the Secretary chooses to take. It is of interest to note that some members of the sugar industry believe the Secretary is not taking full advantage of his powers to insure their welfare. However, some professionals who have studied the United States sugar policy have suggested that the benefits of a domestic sugar industry are considerably less than the cost of maintaining this industry and that policy be redirected in favor of increased imports. Given the current posture toward the removal of government agricultural controls, it seems that a ruling by the Secretary in favor of increased prices for the domestic sugar industry cannot be automatically expected.

Satisfaction of one purpose could also be in conflict with another. In view of current pressures to keep food prices down, the need for ample sugar supplies at reasonable prices might well receive greater weight than other considerations.

Current price ceilings due to wage and price controls have tended to hold down any normal price increases which might be expected in the entire sweetener industry. With the termination of such controls or allowable adjustments, there will probably be some movement of prices upward due to the depressed earnings of the entire sugar industry.

It is felt, however, that price increases specifically geared to water pollution control costs are not possible under the existing conditions of the Sugar Act and current government policy. For the rest of the analysis, therefore, it is assumed that there will be no price increase.

B. Financial Effects

Measurement of financial effects of water pollution control in the cane sugar refining industry requires knowledge of the existing financial condition of the industry to serve as the baseline projections of key financial indicators following pollution control implementation. These estimates were based on model plants described in Chapter II and the incremental costs by model plants as discussed in Chapter V.

1. Profitability

As shown in Chapter II, the cane sugar refinery industry is not highly profitable with after-tax returns on invested capital from negative 4.5 to positive 3.7 percent. Thus, any investment increase without profit increase will only compound low profitability.

Profitability effects for purposes of this analysis will be measured on a discounted cash flow procedure and assume no price increases.

Present values were computed using both a 6½ percent and a 7½ percent discount rate, which is the approximate after-tax cost of capital (equity and debt) in the cane sugar refinery industry as was shown in the computation in Chapter V. A higher rate would make these impacts more severe and a lower rate would reduce the impacts. In these terms, present value of cash flows, after adding pollution control costs, show a significant financial impact with either discount rate.

In order to apply the discounted cash flow procedure to the sugar refineries, certain steps have been taken. First of all, the costs of various alternatives of water pollution control -- both investment and annual operating costs -- have been applied to specific model refineries. Discounted cash flows, assuming a 6.5 percent and a 7.5 percent rate after taxes, were computed for two cases -- before (Base case) and after (BPT and BAT) were computed for pollution control.

The results of these runs are shown in Table VI-2. The specific costs for each level of treatment technology were taken from Table V-7 for BPT and V-8 for BAT. Water pollution control costs from these tables varied from zero to as much as $790,000 for the C-7 refinery for 1977 BPT guidelines. For the BAT 1983 proposed guidelines, the incremental costs varied from zero to $766,000.

It was the costs from Tables V-7 and V-8, added to the appropriate model base case that resulted in Table VI-2. Refineries that had zero costs show no impact. Refineries such as C-7 that needed Alternatives B, D and E-1 show an impact by having the net present value of a targeted discounted cash flow of 6.5 percent drop from $3,949,000 before pollution control costs to a negative amount. This negative number indicates that the model plant, when impacted by costs of pollution control, cannot maintain a cash flow that will meet its or the industry's profit targets.

Approximately 30 percent of the total capacity of the industry does show some impact from the costs of these levels of control. The total impact on these plants will be discussed in the next section. Further examination of the data in Table VI-2 indicates that the cost required to institute treatment alternatives, E-1 or E-2, for condenser water has an impact on all refineries. From Table V-8 it can be seen that 22 of the 29 plants will have investment costs for a condenser cooling tower or a spray pond. Even more significant are the annual maintenance and operating costs which, at over $100,000 per year, are significant and markedly affect the current net values.

2. Capital Availability Level

As discussed in Chapter II, the cane sugar refining industry as a whole appears to be hard pressed to attract new capital. The imposition of new capital requirements, particularly for non-productive assets, would appear to be a problem for the entire industry. However, as previously pointed out, this problem is not more significant for any particular segment of the industry but will depend upon a company's individual earnings. The health of an individual company and its ability to show performance ratings superior to other plants in the same group rest upon its current managerial competence, its past management philosophies, and the degree of its employee's cost consciousness.

C. Production Effects

Of critical interest is the production impact which the cost of pollution control may cause. This effect is shown graphically by looking at the results of discounted cash flows and estimating the potential plant closures due to the impact of costs of water pollution controls. As discussed in Chapter IV, the study compared shutdown model plant characteristics to those of industry firms.

Table VI-2. Discounted cash flow for model refineries impacted with water pollution control costs from specific refineries

	Alternative Needed [1]	Base		BPT		BAT		Percent of total production
		6.5	7.5	6.5	7.5	6.5	7.5	
		$000						
Liquid	C, E-1	1,345	892	1,037	604	815	402	4
Liquid	C	1,345	892	1,037	604	1,009	578	1
S. [2] Crystalline Rural	C, D, E-1	701	170	(1,258)	(1,666)	(1,724)	(2,095)	1
S. Crystalline Rural	C, E-1	701	170	421	(93)	(100)	(568)	2
S. Crystalline Rural	C, E-1 [3]	701	170	421	(93)	421	(93)	2
L. [2] Crystalline Rural	C, E-2	1,849	681	1,569	418	1,132	20	2
L. Crystalline Rural	C, E-1	1,849	681	1,569	418	1,309	179	2
L. Crystalline Rural	D, E-2	1,849	681	(725)	(1,734)	(1,734)	(2,674)	9
L. Crystalline Urban	E-1	3,949	2,076	3,949	2,076	1,019	1,015	38
L. Crystalline Urban	C, D, E-1	3,949	2,076	2,786	(693)	(208)	(1,812)	22
Refineries requiring pollution control investment TOTAL								83
Refineries with no pollution control required								11
Refineries with negative cash flow, therefore not considered in this analysis								6

[1] Costs are for levels of technologies per Supplement A of Development Document Effluent Limitations Guidelines.

[2] S = Small; L = Large

[3] Needs only sand filter.

3. Potential Plant Closures

Present values were computed at 6.5 and 7.5 percent after tax cost of capital for each of the models as shown in Table VI-2. Table VI-3 shows by plant type, the expected degree of impact resulting from the increased control cost investments and operating costs. Those demarked as "H" show a high degree of impact and closure probability. Obviously, however, plant closures are not so arbitrarily determined. Numerous considerations (see Chapter IV) will inevitably influence such decisions.

Table VI-3 considers a number of industry plant variables that are influential determinants of plant closures. The following discussion briefly considers these and the assumptions that are germane to them.

a. Capacity: Economies of scale suggest that plants in which production is greater than that of their representative model will be impacted less than would their model. Conversely, plants with lower production will be impacted to a greater degree.

b. Ownership: Independent, single plant firms whose production is not essential to other vertically integrated company operations are more vulnerable to closing. Plants owned by a multi-refinery company are vulnerable to the degree that their production may be efficiently absorbed by other company units.

c. Location: Rural and urban locations differ in their costs and, thus, in their DCF analysis; however in no case are these differences considered consequential.

d. Climate: Because of the significantly higher costs of constructing and maintaining cooling towers and spray ponds in severe winter areas, those plants so located are, to that degree, more vulnerable to closing.

e. Market Advantage: Plants with little or not area competition have distinct pricing advantages within their marketing area. Too, plants located at or near the pricing center of a marketing area will realize cost advantages to the degree that they have no freight or handling costs.

Table VI-3. Factors considered in cane sugar refinery closure analysis

Code	Capacity TPD	Ownership type	Integrated with mill	Rural Urban	Winter climate	Market advantage	Discounted cash flow Base	BPT	BAT
C 1	2,600	Multiplant		U	Mod.	0	L	L	L
C 2	2,100	Multiplant		U	Severe	0	L	L	L
C 3	3,250	Multiplant		U	Mild	0	L	H	H
C 4	2,100	Multiplant		U	Mod.	0	L	L	L
C 5	1,000	Multiplant		U	Severe	0	L	L	L
C 6	190	Integrated	X	R	Mild	+	M	H	H
C 7	3,500	Integrated	X	U	Mild	-	L	H	H
C 8	1,500	Single		U	Mild	-	L	L	L
C 9	2,000	Single		U	Mod.	0	L	L	M
C 10	1,200	Single		U	Severe	0	L	L	M
C 11	1,500	Multiplant		R	Mild	-	M	H	H
C 12 1/	350	Multiplant		R	Mild	-	M	M	M
C 13 1/	1,700	Single		R	Mild	-	M	H	H
C 14 1/	2,200	Multiplant		U	Mild	-	L	L	L
L 1 1/	300	Multiplant		U	Severe	+	L	L	L
L 2	800	Single		U	Severe	+	L	L	L
L 3	850	Multiplant		U	Severe	+	L	L	L
L 4 1/	390	Multiplant		R	Mild	-	L	L	L
L 5	100	Integrated	X	R	Mild	+	H	H	H
CL 1	1,800	Single		U	Severe	+	L	L	M
CL 2	820	Multiplant		U	Severe	+	L	L	M
CF 1 1/	460	Integrated	X	R	Mild	-	M	M	M
CF 2	700	Integrated	X	R	Mild	-	L	L	M
CF 3	660	Integrated	X	R	Mild	-	M	M	M
CF 4	700	Integrated	X	R	Mild	-	L	L	L

continued.....

Table VI-3. Factors considered in cane sugar refinery closure analysis (continued)

Code	Capacity TPD	Ownership type	Integrated with mill	Rural Urban	Winter climate	Market advantage	Discounted cash flow Base	BPT	BAT
CF 5	220	Integrated	X	R	Mild	+	H	H	H
CF 6	600	Integrated	X	R	Mild	+	H	H	H
CF 7	400	Integrated	X	R	Mild	+	H	H	H
CF 8	700	Integrated	X	R	Mild	+	H	H	H

1/ Eleven percent of total refinery production now has no effluent discharge except to municipal sewage system.

Implicit in the DCF analysis, also, are two further considerations:

1. The unique characteristics of the Puerto Rico operations make them difficult to assess. These plants are significantly impacted at the baseline as well as at BPT and BAT levels; however, the plants are, in effect, subsidized by the Commonwealth of Puerto Rico. As the costs of pollution control are imposed, it is difficult to determine if Commonwealth subsidization will increase or if production efficiency will be sought through plant consolidation.

2. Five refineries (as indicated) have already achieved zero effluent discharge levels and will, consequently, be unaffected by control requirements.

An analysis of these industry plant variables indicates that, in the contractor's judgment, there is a significant probability that three refineries may close as a result of the incremental costs of pollution controls. Further, an additional two refineries are moderately enough impacted that they too may close. While these plants are most seriously impacted by the combined costs of BPT and BAT controls, the impact of BPT controls is effectual enough to project such closure in 1977 even in the absence of the 1983 BAT costs.

Twenty-four of the 29 plants therefore, based on the information, costs, and other conditions previously stated, would, at this point, appear to have a low impact and a low likelihood of closure. Those plants that are highly impacted represent 10 percent of the number of plants (3) and 6 percent of productive capacity (2020 TPD). Plants which are moderately impacted represent another 7 percent of the plants (2) and an additional 5 percent of production (1700 TPD), and those plants least impacted represent 80 percent of the plants (23) and 89 percent of the production (30, 770 TPD).

Two of three plant closures are in Puerto Rico and represent two percent of the production. Their lost production can easily be absorbed by other underutilized Puerto Rican refineries.

The 9 percent balance of lost production is on the mainland and there is little likelihood that it will be absorbed by other production. Low industry earnings indicate against further refinery construction.

It is speculated that the following events might therefore take place:

(a) Domestic raw sugar now going to a closed refinery would be diverted to another refinery and the import quota lowered by 9 percent.

(b) The 9 percent cane sugar loss may be absorbed by beet sugar production.

(c) Substitute sweeteners might take over the 9 percent loss as both caloric and noncaloric sweeteners are expanding their share of the sweetener market rapidly.

2. Sensitivity Analysis

As shown above, the impact of pollution control costs on potential plant closures is believed to be moderate; however, should pollution control costs differ from those used in the analysis, the projected impacts would differ. To gain an insight into such changes, an evaluation of Table VI-2 along with pollution control costs will form the basis of a sensitivity analysis.

As a point of reference, key data from Tables VI-2, V-7 and V-8 are displayed in Table VI-4 by refinery model. As can be seen, an additional investment of $156,800 and $18,400 O&M costs for pollution control in liquid refineries reduces the net present value by $200,000. For type 2 plants, a small investment of $56,000 and $20,300 O&M costs reduces NPV to below zero. In the case of the model No. 3 units (large rural), an investment of only $270,000 reduces NPV by $400,000. This suggests that an additional $100,000 to $150,000 investment and associated O&M costs would reduce NPV to zero and would further possible closures. A similar pattern exists for the model No. 4 plants (urban), although the absolute level of investment is greater.

These data could be plotted and additional indicative analyses performed in order to assess possible impacts of differing control levels and costs.

The essential point is that the imposition of stricter BPT and BAT standards, with presumably higher costs, would lead to a much higher potential closure rate.

D. Employment Effects

Cane sugar refineries do not employ large labor forces for the size of their output when measured in dollars or tons. A small refinery may employ as few as 32 full time people and a large refinery might employ seven or eight hundred people. The industry employs a high percentage of unskilled workers to handle sugar and to operate materials and handling equipment. The skilled technicians are involved in plant machinery operations.

Table VI-4. Sensitivity of model net present values to effluent treatment costs

Type Refinery	Net Present Value Before Impact	Effluent Control Costs: Investment	Effluent Control Costs: Annual Operating Cost	Net Present Value After Impact
	$1,000			
1	892	0	0	892
1	892	156	18.4	690
2	170	0	0	170
2	170	56	20.3	(93)
2	170	670	203.6	(2,290)
2	- 1/	670	203.6	--
3	681	0	0	681
3	681	270	40.6	282
3	681	1,295	256.8	(2,615)
4	2,076	709	109	1,015
4	2,076	788	134.1	680
4	2,076	1,498	303.2	(1,752)

1/ This model has negative cash flow

E. Community Effects

Community effects due to closures are difficult to assess. In urban areas, the impact of sugar plant closures would be relatively minor. The loss of value of raw material which is usually imported or shipped a long distance by a domestic industry would not be felt locally. In the case of rural plants where refineries are located in conjunction with raw sugar cane mills, community effects would be greater. In these locations sugar is a prime industry, and its closure effects would be felt throughout the area from the refinery to the mill to the cane grower. The impact of closure as shown in "Production Effects" would indicate that 3 to 5 small communities might be so affected.

F. Balance of Payments Effects

With the implementation of discharge controls, it has been shown that 6 to 11 percent of the cane sugar refinery capacity may be impacted sufficiently to close. Were this to happen, the refining of sugar could be shifted as discussed in "Production Effects" to:

(a) Other expanded cane sugar refineries
(b) Beet sugar production
(c) Importation of refined sugar

If (a) or (b) did not occur, then the increase in foreign imported refined sugar would adversely affect the balance of payments.

At this time it is not known what effect the guidelines will have on beet sugar production although the construction of new beet sugar plants and their resulting new production should offset the loss of production due to the closure of impacted plants. No new cane sugar refineries have been built for many years, and it is doubtful if they will be now.

The possible expansion of current refineries is the most likely event and, therefore, the balance of payments effects should be minimal. One question not yet answered is the impact of pollution control costs on sugar cane mills. Should this segment be impacted and domestic raw sugar production lost, adjustments by the Secretary of Agriculture would undoubtedly take place to increase the flow of imported raw sugar. Such an event would create a balance of payment effect of adverse consequences.

VII. LIMITS TO ANALYSIS

A. General Accuracy

Data gathered were of secondary nature drawn from previously published reports, from private sources, contracted government studies and regularly reported government services. Personal interviews with key personnel of refinery and sugar cane milling companies and trade associations were conducted.

Throughout the study an effort was made to evaluate data and other information used and to update these materials wherever possible. Data were reworked so as to make their presentation clearer in light of the purpose of this report and to the use that is intended.

This analysis, therefore represents a systematic evaluation of the impact of effluent limitation guidelines on the cane sugar refining industry. It must be recognized that judgments based on this study's data can not be absolute. Its estimates represent the best relative conclusions given time and budget constraints.

B. Possible Range of Error

The study contract required that the contractor use the cost data provided by EPA under Supplement A of the Development Document. The following items indicate the range of error that is possible based on the use of the data supplied by EPA and the basic financial data.

Different data series and different sections of the analysis will have different possible ranges of error. Estimated error ranges as an order of magnitude are as follows:

		Error Range
1.	For number, location, capacity and processes of plants	± 0.2%
2.	Price information on products, materials and equipment	±10.0%

		Error Range
3.	Sunk investment	± 20.0%
4.	Plant operating costs	± 10.0%
5.	Land values	$1,000-$100,000 acre
6.	Pollution Control Costs	± 50.0%
7.	Plant closures	± 15.0%

C. New Technology

Two new technologies, not evaluated, which have potential impacts on waste water disposal are in the early stages of consideration or use by the industry.

One is the condensation of sugar vapor by compression rather than by condenser cooling. This technology, not fully developed for application to cane sugar refining, eliminates the need for large volumes of water for condenser cooling, and hence, the entrainment of sugar in the cooling water. Energy is required in the compression process to liquify the sugar vapor, but an advantage of the process is that the heat generated in the compressing phase can be used as heat energy in the total sugar refining process.

"Dry cooling towers" which eliminate or reduce fog production and air pollution are under development. Little data concerning them is available except that both the investment cost and operating expense are projected to perhaps, triple those of currently operating "wet cooling towers".

D. Critical Assumptions

A key variable in the analysis is the potential response of the Department of Agriculture to increased pollution control costs. The Secretary of Agriculture may act in response to industry conditions in order to maintain orderly marketing and supply processes. Further, under the broad terms of the Sugar Act, there are provisions to assure an equitable division of returns from sugar among beet and cane growers, farm workers and processors.

The assumptions governing the cost of those refineries now discharging to municipal treatment facilities are dependent upon two further assumptions: (a) that user charges for the future will be within predictable limits and be economically affordable by refineries, and (b) that no additional forms of refinery pre-treatment will be required.

A final critical assumption is the reliability of the industry's cost data is used in the study. Care was taken in working with these data, but without access by the contractor to the financial information on specific refineries, the necessary assumption of reliability had to be made.

E. Remaining Questions

A further question, critical but beyond the scope of the present study, is the eventual effect on the refinery industry of the impact of pollution controls on the cane sugar milling industry. The mill's water pollution problem is more difficult by a factor of at least two than is that of the cane sugar refineries. The ultimate impact on many refineries may depend on the impact of pollution controls on the mills because of integrated ownership and the location proximities of mills and refineries.

Further questions depend on costs, the adequacy of treatment technology, and the relations with municipal sewage systems alluded to in the previous section.